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IN MEMORIAM.

Dr. M. K. VENKATA RAO, M.A., M.Sc., Ph.D.

The tragically sudden death of Dr. M. K. Venkata Rao has deprived the Department of one of its unique figures.

Born in 1889 at Ulchala, Kurnool District, he had his early education in the High School at Kurnool. In 1902, he joined the Presidency College, Madras, took his B.A. degree in his seventeenth year, and continued for a year his post-graduate studies. He was the recipient of the Palniyandi Gold Medal for proficiency in Botany. In contrast to his later life in Mysore, he practically avoided sports during his College career. He was the moving spirit of the Natural Science Association of the College and was the centre of admiration for us under-graduates owing to his thorough knowledge of the plant ecology of Madras. The thought sadly surges to my mind that on one of our excursions to the sea coast at Mahabalipuram three of us rescued him from the clutches of the sea.

While yet he was studying for his M.A. degree, he was appointed as Senior Assistant Mycologist in our Department. A student yet fresh from the College, unacquainted with practical difficulties of the problem, he was posted to organize the campaign against the Koleroga of the Arecanut in the Malnad. Possessed with an indomitable will, though with an indifferent health, he trudged from village to village braving the inclemencies of the weather. The pioneer work he had done in the areca gardens of the Malnad could be really appreciated only by those, like Dr. Coleman and myself, who have gone through the ordeal. His memory is cherished even to-day in many of the interior villages of the Malnad.

Alongside with this work, he was engaged in building up and laying out the Marthur Farm near Thalaguppa. During his tours, he had unique opportunities of studying the agricultural operations of the area; this stood him in good stead in conducting the Farm activities. The first areca drier, for which there has been some demand in the Malnad, was built by him on the Marthur Farm.

In 1912 he took the M.A. degree of the Madras University, writing a valuable thesis on Azotobacter. In 1919 he was awarded the Damodar Das Scholarship for Agriculture. He took his Doctorate degree at the University of California, and M.Sc. at Cambridge.

Being a versatile man, he served in many capacities in the Department, as Mycologist, as Officer-in-Charge of the Fodder Campaign, as Headquarters Assistant, and finally as Deputy Director of Agriculture. While the last, he did for Coffee what he had originally done for Areca. He was engaged not only in organizing the spraying work against coffee diseases but also in building up the Coffee Experimental Station. In this connection he went on a deputation to Java, Sumatra and other places.

Those who came in touch with Dr. Venkata Rao were struck with his versatility from the beginning. Thanks to

his keen observation and memory, he had a working knowledge of many things. He was a mechanical engineeer, an electrician, and even had sufficient practical knowledge to manage a printing press or a railway station. He worked heart and soul for the Scout Organization wherever he went. He was the Assistant District Scout Commissioner of Rover Scouts, Kadur District, and a member of the State Scout Council. Many a scout will long remember his cheery conversation round the camp-fire. His love of music, developed during the latter part of his life, was intense. He had a plan for presenting Indian songs in the form of notations along the lines of Western music.

Among his civic activities must be mentioned the starting of the Dolphin Swimming Club, and his attempts to improve the Kempambudhi Tank in Bangalore. A cultured man that he was, he worked on the Marthur and Balehonnur Farms like a veritable cooly. Pride of position or culture never stood between him and the humblest individual.

By his death the Department has lost an able officer, who was ready to shoulder any tough work, and his many friends, a genial companion.

M. J. NARASIMHAN.

THE FOURTEENTH ANNUAL SESSION OF THE AGRICULTURAL AND EXPERIMENTAL UNION

Held at the Daly Memorial Hall on 22nd December 1932

Speech by Dr. Leslie C. Coleman, C.I.E., M.A., Ph.D.

President of the Union

MR. RAJAGOPALACHARI AND GENTLEMEN,

I do not intend to inflict upon this audience a long speech this morning as there are a number of subjects on the programme for discussion. In the first place, I wish to welcome you, Sir, and other visitors to this Annual Meeting of the Union. In welcoming you I trust you will permit me, on behalf of the Union, to congratulate you on your appointment to one of the highest and one of the most responsible offices in the State. As Revenue Commissioner your interest in agricultural work has been known to us all, and I consider and I know that the members of the Agricultural and Experimental Union and the staff of the Agricultural and related Departments consider too, that we are extremely fortunate that you now are in a position to guide the destinies of the Agricultural Department and its activities in the State.

I should like on one or two points to anticipate the report of the Secretary which, I regret to say, is not the most cheerful reading one could imagine. The progress of work of the Union has, I must admit, not been satisfactory. There are a very large number of factors which account for this. As you know, one of the main functions of this Union is to co-operate with the Agricultural Department in the testing, scientifically, of all improvements—improvements either in the production of new seed, new implements, better methods of manuring, better methods of cultivation, control of insect pests and fungus diseases. It is perhaps rather too much to expect agriculturists, even intelligent and progressive ones, at a time when they are finding it extremely difficult to cover the expenses of operations on account of the very depressed condition of the market, to devote a large amount of time and money to carry out experiments. After all, anyone who is familiar with the technique of experimental work in the field must know that experiments cannot be carried out without

an outlay on the part of the agriculturists. We attempt to keep that outlay as low as possible and to confine the experiments to small areas, so that the actual amount of labour and supervision is reduced to the minimum. Nevertheless, extra labour and extra supervision are both required if experimental work is to be carried through to any sort of satisfactory conclusion. I appreciate the difficulties of the situation. Nevertheless, I would urge upon all the agriculturists here to-day and all intelligent agriculturists throughout the State that if we are to progress, if we are to improve our agricultural conditions, it must be on the basis of actual field experiments. That, I have mentioned on many occasions at the Annual Meetings of the Experimental Union from its very inception. You cannot entirely depend upon the experiments that are carried on on our Government farms and in our laboratories to suit all conditions; after all, these are situated in certain definite areas and we cannot spread them over every Taluk in the State. Nobody can foresee exactly whether the results that we obtain on a particular experimental farm, whether it be from a variety of seed, a new implement, new manure or manuring with a different combination of manures, will be applicable to the private farms, say, 100 or 50 miles apart. It is impossible for us to foretell that on account of the peculiar soil and climatic conditions that exist in the Mysore State and their variations which are greater here than you will find in almost any other part of India. One of the main functions of the Union should be to carry out the co-operative tests that are absolutely necessary. I do not think I need say any more on this point. I urge upon the agriculturists, notwithstanding the present conditions of agriculture, that they should devote time, attention and at least a small amount of money in connection with the supervision and labour. The Union will as far as possible supply seeds and manures for the experiments.

There is another feature of the work of the Union which I regret to say has not progressed. The Secretary reports that it has been extremely difficult to obtain contributions in sufficient number to issue the numbers of the Journal in time. The Kannada Journal, written almost entirely, I believe, by our Secretary, is on a different footing and I believe it is looked upon as of very general value to the State. It is quite a different thing with the English Journal. I appreciate the fact that most of the contributions to that Journal,

if they are to keep a very high standard, must be furnished by highly trained technical men. That means that the officers of the Agricultural and related Departments must be responsible for the bulk of the contributions. Even in this regard, the officers of the Department have hardly come up to expectations. I would urge upon these gentlemen—the gentlemen who have given promises on various occasions to submit contributions—that they should fulfil their duties in this regard. It is not because information is not available in the Department. There is a mass of material collected by the Agricultural officers. I do think it is a great pity that a very large amount of extremely valuable information is not being given out to the public. I am afraid that, in the case of some of the officers of the Department who are approaching retirement, a good deal of the information would pass away with them and never be published. I recall that fifteen years ago I myself had taken rough notes of observations on important subjects which, had they been written up fully and published, would have been of value to the general public. These observations are now lost. I think there must be quite a large number of officers who are before me to-day and who are exactly in the same position. I would urge upon these officers the necessity of placing in such a form as can be of general use to the public the information which they have collected over a long series of years of their service. After all, we must remember that we are serving the people. We have no right to allow valuable information to be lost and therefore it should be furnished to the people who pay for it. I am not referring only to the officers of the Department. I am referring also to the large number of gentlemen who are sitting before me to-day and who have collected a great deal of information with regard to local agricultural conditions either through co-operation with the Department or of their own accord. They have collected information which is not directly traceable to the Agricultural Department. They are quite capable of introducing improvements of their own. I realize that private agriculturists in general probably have not much experience in putting their information into a form suitable for publication. What I could urge upon those gentlemen is this. Do not be afraid of your language. We have a staff in our Agricultural Department which is quite prepared to make it fit for publication in proper form and language.

When you were Revenue Commissioner, Sir, you took a particularly active interest in attempting to bring the Vernacular Journal especially to the attention of the Village Panchayets of the State. This Vernacular Journal, I consider, is the best medium we have in the State, at present, for bringing improvements recommended by the Agricultural Department to the general agricultural public. I look upon the Village Panchayets as a whole as the best medium of getting that information to the agriculturists in the State. You sent out definite instructions to the Revenue Officers of the State that the Journal should be popularised among these bodies. I regret to see, now, that the response has been extremely poor. You are now a Member of Government and I would ask you, Sir, to use your influence in this connection. The possibility of improving this Journal and of reducing its cost and similar questions will come before this meeting and definite proposals will be put before us for consideration. I do feel that until we are able to get our Vernacular Journal into the hands of a very large number of Village Panchayets in the State, we shall not be doing anything like what we ought to do with regard to publicity. Government is giving us a subvention and that subvention should be used in spreading the valuable information among agriculturists. If this is not done, I think, it is high time that the publication of our journal ceased.

I have talked enough, I suppose, on the dark side of the picture. To-day the conditions of the agriculturists in the State, all over India and, I may say, all over the world, are anything but satisfactory. To-day is the very day when we are to make strenuous efforts to improve and increase our efficiency. When ragi was being sold at 10 seers a Rupee, it was not difficult to make a profit from its growth. When it is being sold at something like 20 seers, it is quite a different story and I may say that I can hardly see how those who are depending upon Ragi can get the money to pay for their most important commitment, *viz.*, taxes, and in addition to pay for their barest necessities. That means, we must reduce the cost of operations in some way or other, and some means must be devised to increase the efficiency of the agriculturists if they are to stand on their feet.

Gentlemen, there is one bright picture that I must place before you to-day in connection with an important subject for discussion on the programme. Although most agricultural crops are under

extremely depressed conditions owing to foreign competition, there is one crop for the production of which a paying price is assured. It is the sugarcane crop. That price, thanks to the foresight of the Tariff Board which is visiting us to-day and of the Government of India, has been assured for the next ten years. That price, I believe, under efficient conditions of cultivation and manuring, will enable the ryot to make a profit. Luckily, the area that can be brought under sugarcane in the State has been enormously increased as a result of the construction of the Krishnarajasagara Reservoir. We have heard in the Legislative Council and in the Press a certain amount of discussion on the subject of sugarcane cultivation and sugar manufacture in the State and I should like to add further, certain general observations. In the first place, I should like to point out to you that the success of sugar manufacture in this State or in any other part of India is largely an agricultural matter. The technique of sugar manufacture has been so advanced in recent years that you are almost sure, with reasonable care, of getting efficiency in manufacturing operations. In the Mysore State, luckily, we are very much better situated with regard to conditions for sugarcane cultivation than in most other parts of India. With an efficient plant working in this State, and with cane grown as it should be grown, I can see no reason why we should not obtain yields approximately to those now obtained in Java. In Java, at present moment, the average production of sugarcane on an area of 4,00,000 acres is about 50 tons per acre. You will therefore see how far we have to go so as to be able to reach the position in which Java stands at present so far as sugarcane cultivation is concerned. We are anticipating during our first year in the Irwin Canal area from the ryots' fields a production of 25 tons of cane per acre and we may get more. As at present arranged the tariff on sugar will cease after a certain definite time and within that time we should be able to increase our efficiency in production so as to meet foreign competition. The people of Mysore should not keep idle but make strenuous efforts to make their fields yield greater tonnage of cane. Now, gentlemen, you will see what a bright future and what a task we have before us. Personally I am rather doubtful, even after that period of ten years, that tariff on sugar will be removed. But even under those conditions, I should be personally extremely sorry if we allow ourselves to sit idle and be satisfied with what

we can produce now, simply because we can make some money owing to that tariff wall. I see no reason why at least 40 tons of cane per acre should not be produced and even if the tariff wall is removed, why the Mysore sugar industry should not be able to stand on its own feet.

There is one other question on which I have to say something. You will remember that in the course of discussions that have occurred during the last two or three weeks on this subject, it has been said that Government should have nothing to do with the sugar industry in the Irwin Canal area and that private enterprise should be encouraged to have its way and allowed to work its own sweet will and that it should be a question of the survival of the fittest. Gentlemen, I think we have already enough evidence in this world to-day of the disastrous effects of that wonderful law of supply and demand and its disastrous effects upon both the agriculturists and industrialists. We must be cautious. Although perhaps you may say I am prejudiced as a Government Officer, I am firm in my conviction that, to safeguard the interests of the ryots as well as of the industrialists, Government must at the beginning at least play an important part in the development of the sugar industry of the State.

I wish again, Sir, to welcome you to our meeting and to express our very sincere thanks for the honour you have done to us in presiding over this function to-day.

Annual Report by the Secretary

I have much pleasure in submitting the annual report for the year 1932.

The Union is a body of agricultural experimenters as is now well known. The following statement gives details of the experiments for which material was supplied to the members during the years 1931 and 1932. Excepting in a few cases the results of trials during 1932 are not available yet.

Material for the various experiments was supplied as follows :—

Seed—

Varieties.	Number of Experiments. 1931.	1932.
Ragi	20	12
Groundnut	12	13
Paddy	20	11
Sugarcane	25	10
Cotton	7	3
TOTAL ..	84	49
Manurial—		
Paddy	17	..

The crop year 1931 was very unfavourable for dry-land crops. Due to continued drought after sowing the seeds did not germinate at all or suffered from drought after sprouting. The low prices of the food crops prevailing during the two years have been rather discouraging to the members in the undertaking of experiments. A few reports of yield have, however, been received and are given in Statement (I A). The results for 1932 are given in Statement (I B). H22 ragi has given the best yield in 1931. It has done best in 1932 in Chikballapur. A new variety, H45, was given for trial during 1932. Under partial irrigation this variety has yielded 16 pallas of grain and two cart-loads of straw as against 10 pallas of grain and one cart-load of straw of giddaragi, the local variety, but it was harvested one month later than the local variety. H45 has done well both as a dry and semi-dry crop, the difference on account of slight irrigation being nearly double.

GROUNDNUT VARIETAL TESTS, 1931 and 1932.

These are given in Statements (II A) and (II B).

H.G.1 groundnut has yielded better than the local varieties in all the trials during 1931. A new variety, Valencia, was given out for trial in 1932. This has done better than local in one place. H.G.1 has done better than local in the other trials. There is an interesting point to be noted in trial conducted by Mr.K. T. Narayanagowda. It is found that empty pods are not a feature of H.G.1 variety. The local variety gave more empty and partly filled pods. The belief that H.G.1 gives more empty pods than other varieties has no experimental support. One experimenter has stated that

H.G.1 was not accepted by an oil-mill as a good variety. It was considered an edible variety. The percentage of oil in this variety is not so high as Small Japan but distinctly higher than the local edible variety. But mill tests on a large scale have not been conducted, and as the variety is spreading in cultivation it seems quite necessary to obtain oil-mill reports for this and other varieties immediately.

Paddy Varietal Tests.

Many of the members who received seed did not attempt the trials due to uncertainty of water supply in their tanks. The results of the successful experiments are given in Statement III. G.E.B. 24 has done better than the local in all the trials.

During 1932, some new varieties have been given out for trials from the Nagenahally Paddy Breeding Station. The results have not been received yet.

Sugarcane Varietal Tests.

There have been failures due to insufficient water supply as in the case of paddy, but there has been failure due to water-logging also. The results of successful trials are given in Statement IV. Quite a large number of experiments have proved of no value either because no local varieties were grown for comparison and the plots laid out properly or because the varieties were mixed up during harvest.

Field Day on the Nagenahally Paddy Breeding Station.

A very successful field day was held on the Nagenahally Paddy Breeding Station on the 7th December, 1932, to acquaint our members with the work which is being done there. Although the number of visitors was large, the number of members who visited the Station was not quite as good as it is usual when the field day is held on the Hebbal Farm. The elections to the Committee were therefore not held.

The Journals of the Union.

The English Journal has not been issuing regularly. Only one number has been printed during the year. This is entirely due to paucity of contributors. Efforts are being made to publish this edition regularly.

The Kannada monthly Journal is, however, being published regularly. Thirteen issues have been published since January 1932.

Hardly any Village Panchayets are subscribing for our Kannada Journal during this year. The Revenue Commissioner (the Chairman of this Meeting) issued special instructions to the Deputy Commissioners and Amildars to encourage subscription to the Journal by the Village Panchayets. The Director of Agriculture wrote personally to the Amildars requesting them to popularize the Journal among Village Panchayets. The Journal itself is made interesting and instructive specially to the Village Panchayets. Yet, it is found that these bodies have not been giving the Journal the patronage it deserves. The Committee have considered this matter and are putting forward definite proposals for the improvement of circulation.

Thanks to the continued interest evinced by the Director of Public Instruction, 78 middle schools have been subscribing for the Journal.

The Committee of the Union desire to record their appreciation of the continued support received by the Union from the Government and trust that similar support will be accorded to it in the future in its efforts, to improve the agriculture of the State along scientific lines.

The statement of receipts and expenditure is appended.

STATEMENT I A.

Statement showing the Results of Ragi Varietal Tests during 1931.

Name of Experimenter.	Variety.	Total area of the plot.	Actual yield.	Yield per acre.
1. Mr. Hutchegowda, Servagarpalya.	H. 22	....	....	310 seers.
	H. 40	....	....	270 ,,
	H. 2	....	....	310 ,,
	Local	....	....	180 ,,
2. Mr. N. Gundappa, Nagasandra.	H. 22	....	....	160 ,,
	H. 40	....	....	177 ,,
	Local	....	....	160 ,,

Statement I B.

Results for 1932.

Name of Experimenter.	Variety.	Total area of the plot.	Actual yield.	Yield per acre.
1. Mr. Byrappa, Marasanahalli, Chikballapur.	H. 22 H. 40	1/20 acre. 1/20 ,,	30 seers. 24 ,,	600 seers. 480 ,,
2. Mr. K. T. Narayanagowda, Kalludi, Goribidnur.	Giddaragi S. 15–6–32 H. 28–9–32	1/5 ,,	208 ,,	1040* ,, Straw 1 cart-load.
	H. 45 S. 15–6–32 H. 30–10–32	1/5 ,,	321 ,,	1605* seers. Straw 2 cart-loads.
3. Mr. Narasiyappa, Gedare, Goribidnur Taluk.	Local S. 29–6–32 H. 30–10–32	3½ guntas.	40 ,,	457 seers. Straw half cart-load.
	H. 45 S. 29–6–32 H. 30–10–32	3½ ,,	45 ,,	514 seers. Straw half cart-load.
4. Mr. T. Laxman Reddy Sabbanahalli.	Local H.45	4 ,, 4 ,,	73 ,, 95 ,,	730 seers. 950 ,,

*Irrigated Crop.

Statement II A.

Statement showing the Results of Groundnut Varietal Tests during 1931.

Name of Member.	Variety.	Area.	Yield.	Yield per acre.	Remarks.
1. Mr. Puttanarasegowda, Vatadahosahalli.	H.G. 1 Local.	.. ..	.. ..	1,260 lbs. 1,160 ,,	
2. Mr. K. T. Narayanagowda, Kalludi, Goribidnur ..	Local.	..	..	1,204 ,,	41lbs. empty pods and 53 lbs. partly filled pods.
	H.G. 1			1,960 lbs.	21 lbs. empty pods and 41 lbs. partly filled pods.

Statement II B.

Results for 1932.

Name of Member.	Variety.	Area.	Yield.	Yield per acre.	Remarks.
1. Mr. Appareddy, Korenhalli, Chikballapur.	Valencia	1/20 acre.	30 seers.	600 seers.	There were a number of empty pods.
	H.G. 1	1/20 acre.	24 seers.	480 seers.	
2. K. T. Narayanagowda, Kalludi, Goribidnur.	Local S. 7-7-32 H.30-11-32	½ acre.	621 lbs.	1,242 lbs.	Empty and partly filled pods 84 lbs.
	H. G.1. S. 7-7-32 H.30-11-32	½ acre.	886 lbs.	1,717 lbs.	Empty and partly filled pods 50 lbs.
3. Mr. Narasiyappa, Gedare, Goribidnur.	Local	3/20 acre.	193 lbs.	1,286 lbs.	Empty and partly filled pods 46 lbs.
	H.G.1.	3/20 acre.	238 lbs.	1,588 lbs.	Empty and partly filled pods 80 lbs.
4. Mr. Thimmegowda, Sonaganahally, Goribidnur.	Local	1/10 acre.	101 lbs.	1,010 lbs.	Empty and partly filled pods 110 lbs.
	H.G.1	1/10 acre.	123 lbs.	1,230 lbs.	Empty and partly filled pods 130 lbs.
	Small Japan	1/10 acre.	102 lbs.	1,020 lbs.	Empty and partly filled pods 150 lbs.

Statement III.

Paddy Varietal Tests for 1931.

Name of Member.	Variety.	Yield per acre.	Remarks.
1. Mr. Thimmappa, Molakalmuru Taluk.	Halubbalu (Local)	1,250 seers.	Seed intended for Mr. Ramdas, Challakere.
	G.E.B. 24	1,500 seers.	
2. Mr. Byra Reddy, Polampally ..	G.E.B. 24	1,086 seers.	
	Local.	1,153 seers.	
3. Mr. N. Gundappa, Nagasandra	G.E.B. 24	813 seers.	
	Halubbalu (Local)	590 seers.	
4. Mr. M. Subba Rao, T. Narasipur	G.E.B. 24	2,094 seers.	2,569 lbs. straw.
	Local.	1,647 seers.	2,470 lbs. straw.

Statement IV.

Sugarcane Varietal Tests for 1931.

Name of Member.	Variety.	Yield per acre.	
		Cane.	Jaggory.
1. Mr. Lakkanna Gowda, Banasandra ..	H.M. 320	79,520 lbs.	....
	R.M. 27/6	45,547 lbs.	
	Cheni	78,400 lbs.	....
2. Mr. S. Laxmana Reddy, Sabbanahalli, Goribidnur Taluk.	H.M. 320	49,369 lbs.	6,630 lbs.
	H.M. 553	48,384 lbs.	6,066 lbs.
	Babbur striped	49,771 lbs.	6,174 lbs.
	Rasathali	48,320 lbs.	5,795 lbs.
	Pattapatti	49,076 lbs.	5,740 lbs.
3. Mr. K. T. Narayanagowda, Kalludi, Goribidnur.	Local	....	*2,997 lbs.
	H.M. 329	....	9,504 lbs.
	Babbur striped	....	7,452 lbs.
4. Mr. Laxmana Rao, Goribidnur ..	Local	....	7,211 lbs.
	Babbur striped	....	8,285 lbs.
	H.M. 320	....	8,621 lbs.
5. Mr. Patel Appareddy, Yellodu, Gudibanda.	Local	....	7,084 lbs.
	H.M. 544	....	6,720 lbs.
	Babbur striped	....	7,448 lbs.

* Poor growth.

Statements of Receipts and Expenditure from 1*st May* 1931 *to* 30*th November* 1932.

Receipts.	Rs.	A.	P.	Expenditure.	Rs.	A.	P.
Opening Balance ..	1,564	9	6	Establishment	2,751	8	4
Admission Fee	114	0	0	Printing	2,897	11	0
Annual Fee	649	0	0	Postage	85	14	0
Subscription	654	4	0	Annual Meeting and Field Day (for 1931) ..	343	13	5
Miscellaneous	7	0	0	Manure supplied to Members of the Union during 1931	16	2	0
Subvention for the years 1931 and 1932 ..	5,000	0	0	Miscellaneous (Stationery, Book-binding, Furniture, etc.)	226	4	0
				Total ..	6,321	4	9
				*Cash on hand	1,667	8	9
Grand Total ..	7,988	13	6	Grand Total ..	7,988	13	6

* Bills pending payment upto 30th November 1932—Rs. 557-12-6.

Opening Speech by S. P. Rajagopalachari, Esq., B.A., B.L. Member of Council

Dr. Coleman and Gentlemen,

It has given me very great satisfaction to have been able to accept the kind invitation of the Mysore Agricultural and Experimental Union to preside over this annual gathering. I am glad to be associated so early in my charge of the portfolio of the Agricultural Department to come into contact with the members of the Union and with the officers of the Agricultural Department. When Dr. Coleman first asked me to attend this meeting I knew that I would be full of other work and it was on that account that I asked for a short postponement. In reality, however, the work was much more heavy than I anticipated. I must frankly confess that I have not had much time to concentrate fully on the agricultural problems with which you are all familiar. I am sure you will forgive me if owing to this circumstance I do not dwell in the usual lengthy manner with technical problems concerning agricultural improvements.

The absence of such a long and formal speech is not going to be of any disadvantage because the Union is professedly formed for practical and experimental work and not for listening to academical addresses especially from laymen. We have heard the very interesting report of work done by the Union for the year 1932. I am glad to see that you are not content with the experiments done so far and that you are taking new lines and new varieties for trial during the year under review. The number of experiments during the current year have somewhat fallen especially under paddy and sugarcane. I presume that it is partly due to the non-receipt of returns from some of the members and not to any lack of interest in the work. I was particularly interested in the sugarcane tests, but owing to various causes the results have not been of a decisive character. I am sorry to note here that both the English and Kannada monthly Journals have not been supported to a very large extent. The large fall in the number of Kannada subscribers is really regrettable, for the Journal is mainly intended for the agricultural classes. I share the regret expressed in the report that the Village Panchayets are not subscribing largely for the Kannada Journal. I believe it is more or less due to the economic condition of the ryots at present more than to any other cause.

One of the most noteworthy features that has struck me in connection with the work of the Agricultural Department in Mysore is the importance it has always attached to popularizing the results of their scientific investigations. It used to be a common-place criticism once upon a time that the ryot has long centuries of experience behind him and is not likely to take to new methods. Nothing can be farther from the truth so far as the Mysore ryot is concerned. The old prejudice against change of methods, if it exists to any large extent, is disappearing and it is my own experience that the ryots are eager to know and to learn and do not take a mere non-possumus attitude. This is due to the policy of the Department always to co-ordinate their work in the Laboratory with the requirements of the cultivators on the field. The carefully selected location of our Agricultural Farms and the nature of the work turned out afford sufficient proof of my statements. I need not refer to the work in the well-established farms like Hebbal and Babbur; but new experimental work undertaken at the Balehonnur Coffee Farm and the Kar Ragi Station near Hunsur are, I know, keenly appreciated by the agricultural classes interested in those crops.

The same spirit of co-operation forms the key-note of the relations of the Agricultural Department with the other departments engaged in the task of ameliorating the economic condition of the masses. I need not enlarge this point but I would give you the instance of the manufacture of the Mysore Plough as one of the most useful results of such co-operation. Hitherto as you all know our improved ploughs have been supplied by a few private firms. The Agricultural Department, however, have analysed exactly the needs of the cultivator and designed a plough which would suit him the best. It has been manufactured in the Industrial Workshop at a cost which compares most favourably with other ploughs. This has become increasingly popular with the ryots and I saw some of them at work at the Ganadalu Farm. There is a similar co-operation between these two departments in connection with power pumping installations. I may also refer to the co-operation between the Agricultural and the Revenue Department of which I was the head till lately. Dr. Coleman originated the idea of popularizing some of the improved varieties of seed through the Revenue Department and as a result we were able to sell a large quantity of the seed, especially

ragi seed, to the ryots. Similarly we were able to be of some assistance by grant of takavi loans, etc., to spread the use of the sprayers in the Malnad.

This brings me to the important question of the relations between the Village Panchayets and the Agricultural Department. I am a strong believer in the efficacy of the Village Panchayets for popularizing improvements of all kinds and especially of agricultural improvements as most of the Panchayets consist purely of agriculturists. The existence of this useful village organization simplifies the work of carrying on propaganda among the villages and the operations of the Department also can be more largely introduced with their help. For instance, I used to encourage them to advance money to their villagers to buy improved implements and seed and then recover it by means of easy instalments. I believe that by preserving in this method a more rapid adoption of improved agricultural methods is sure to result.

I would suggest that this line of approach may be very usefully employed in connection with the large agricultural problems that are confronting us to-day in the Irwin Canal area. The Department with the help of this Union have been specializing in sugarcane and the results of their hard labours in the past have been of utmost value in the Irwin Canal area. It is this knowledge that has enabled Dr. Coleman to take up the cultivation of a particular variety of cane suited to the Mysore climate and soil on a large scale himself in that area and has enabled him to promote the scheme for the immediate establishment of a Sugar Factory. As you all know the task is just begun and the success in the future very largely depends upon the application of the most scientific and intensive methods of cultivation. The opportunities for experimental work are very great and I trust that the Union will attract more members from that area with a view to carrying systematic experimental work there.

Sir, Agriculture is the basic industry in the State and the world-wide depression has affected it as in the case of other industries. The economic return to the ryots has dwindled in money value and his purchasing power has decreased. This has affected also to some extent the work of the Department so far as the sale of improved implements and seed is concerned. I hope this is only a temporary phase. Equipped as you are with a well-trained staff, working in

intimate association with all the agencies engaged in rural work and above all working under the guidance of Dr. Coleman whose phenomenal energy and enthusiasm for his work, great scientific talents and driving power are so well known, the future is full of promise, and I trust that this Union will take an increasingly prominent part in the work that lies ahead of us. I wish every success to the labours of the Union.

Groundnut

BY

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COMMERCE.

A century ago groundnut was only an article of food in the tropical countries. The discovery of its use in various industries created a great demand for groundnut in the European market. It has now become a very important plant product and has assumed such an international importance that the prosperity of many ports and industries now depends upon groundnut trade. As it possesses one of the finest kinds of edible oils and the richest oil-cake in commerce, the demand for it is ever on the increase. Larger areas are now being sown than before the Great War, construction of Railways to transport the huge quantities of nut to the ports of shipment is being pushed on rapidly, and everywhere better facilities for storing and loading are being provided for. As a result of these activities the cultivation of groundnut is assuming a greater importance than ever before and is improving the economic conditions of the cultivators in many a tropical country.

In England groundnut was grown under glass for the first time in 1712 only as a curiosity. But in 1769 Sir William Watson showed pods and oil to the Royal Society and read a paper communicated to him by Browrigg of N. Carolina. Beyond this England took no more trouble to investigate its possible utility at home and develop its vast resources in its tropical dominions.

France, on the other hand, saw the possibilities of this nut as early as 1801 and as has been stated before, made attempts to grow it in the warm south. The attempt failed owing to the Napoleonic Wars and the consequent political disturbances in the country. During 1820-22 as a result of heavy frosts olive yards were greatly

affected and groundnut was again given a trial but owing to bad organization the attempt failed. In 1830 serious havoc was again caused in the olive yards in the severe winter, as a result of which the price for olive oil went up and the wool carders had to go in for a cheaper substitute. At this stage in 1837 the first consignment of groundnut oil was brought into France. A firm in Marseilles put on the market as an experiment 4 or 5 kilograms of groundnut received from Gambia. It was at once a success.

M. Rousseau, a Parisian chemist, at Dakar in West Africa was offered slaves in exchange for some goods. He said to them, " keep your captives, they are our fellow creatures, but in groundnuts I offer you any European thing you like." He saw the possibilities of this oil-seed and was the first man to give a great impetus to its trade. In 1840 M. Rousseau with the help of M. Jean de Saint-Jean bought 6 hectares of land at Rufisque in order to establish a station for monkey-nut trade. Though the prosperity of Rufisque is now declining as a result of diversion of trade to Dakar by railway yet the output from Senegal goes by the name of Rufisque. He sent the first load of 70,000 kilos in a small vessel " Zenith", tonnage 99 tons, under Capt. Gimic. The nuts were pressed at Sotteville-les-Rouen. The oil was a great success on the market and was in immediate demand. M. Gascoin sent from Saint Louis, Senegal, a few sacks to Marseilles at the same time ; no regular trade was started by Rousseau till 1850.

As a result of these attempts the cultivation of the nut began to extend in Senegal and Gambia from 1840.

The demand created was so great that very soon Sierra Leone, Algeria, Angola and Pondicherry in India began to send large quantities of nuts. The opening of the Suez Canal in 1869 greatly enhanced Indian trade. Within the course of twelve years of its introduction into trade, nearly 1,377,482 cwts. of oil per year were produced in France. In forty years great mills were set up in the following places in Europe to crush the seed and express the oil :—Genoa, Bordeaux, Nantes, Dunkirk, London, Rotterdam, Hamburg, Copenhagen and Barcelona. Delft, Trieste, Valencia have also started oil presses now.

Heavy taxation and want of adequate facilities have checked its growth in Angola. The construction of the Nigerian Railways has opened the rich fields of Kano and its neighbourhood. The connection of Dakar with the upper reaches of the Niger by rail and water

has opened up the resources of French Soudan. Gambia still exports large quantities of groundnut. The development of French Soudan may curtail some of the labour supply from Gambia. In India the improvement of wharfing facilities at Madras harbour and railway lines have diverted the trade from Pondicherry to Madras. Australia which is importing large quantities from China is trying to improve its local seed supply and extend its cultivation.

Mozambique and Madagascar have also begun to appear in the market. Argentine is trying to revive its cultivation. The United States of America which was importing large quantities has extended its own cultivation by protective tariffs against importation. There is now practically no import of groundnut into the States but large quantities of oil are still imported. All the nuts grown are eaten as such or are made into peanut butter. Recently they have set up mills to get their own oil. In other tropical countries groundnuts are largely grown to supply the local demand and in India there is a large internal trade.

In an attempt to study the actual figures of exports and imports and the areas under cultivation in various countries I found it extremely difficult to gather the data required from all the countries for every year. In regard to this study the information available is limited and whatever is available is scattered over a wide range of publications. I have therefore attempted to bring together the available data.

Nearly 800,000 tons of nuts were consumed by the mills in Europe in 1924. The supply comes mainly from British territories. India, Gambia and Nigeria alone send about 350,000 tons valued at about £ 4,000,000, and the rest comes from the French colonies and China. Large quantities are grown in many tropical countries but future development depends upon the utilization of by-products, marketing and transport facilities.

The relative importance of groundnut in the world's trade, before the Great War, is shown in the following table. The following quantities were available on the European market :—

Groundnut	625,258 tons.
Coconut	332,921 ,,
Sesame seed	260,780 ,,
Palm Kernels	234,209 ,,
Linseed (1909-13) ..	1,331,701 ,,

Nearly 2 million tons of groundnuts were actually put on the market for sale from various countries. The whole trade was in the hands of French manufacturers, but Germany, Holland and Spain have now begun to compete with Marseilles to some extent. If Britain must attract the trade to her own factories a united effort of all the manufacturers is required to compete with the organized trade of France. Modifications are also necessary to handle groundnuts in presses that are now mainly used for pressing linseed, cotton seed, or rape.

The following table shows the destination of exports from various groundnut-producing countries. The bulk of the produce was from the British Empire. The Great War and the subsequent unstable condition of the finances of the European nations, have upset the normal trade conditions. I have therefore selected the figures for 1913-14 as representing those of a year of normal conditions :—

	Quantity exported cwts.	Value in £
India (1913-14)—		
Exported to France	4,447,593	2,620,541
Belgium	332,157	199,292
Austria and Hungary ..	214,114	111,729
Germany	188,724	115,321
United Kingdom	9,603	5,564
Nearly 80 per cent of the total Indian export was to France and three-fourth of this export was from Madras Presidency.		
Gambia (1913)—		
Exported to France	848,414	385,662
Germany	342,736	162,403
Holland	88,800	39,967
United Kingdom	19,695	10,701
Nigeria (1913)—		
Exported to Germany	188,460	93,668
United Kingdom	186,760	77,693
France	10,440	3,305
Senegal (1912)—		
Nearly 70 per cent of the export was to France.		
Exported to France	2,577,377	1,175,278
Holland	504,767	224,941
Germany	379,073	168,588
United Kingdom	2,063	931
China (1912)—		
Chief destination was to France ..	403,968	230,935

The following table gives the total quantity of decorticated and undecorticated groundnuts imported into France in 1913:—

	Undecorticated.	Decorticated.
From French Territories—		
Senegal	3,420,901	....
Other French West African Possessions	57,560	....
French India	111,656	1,646,057
Other Colonies and Protectorates	403	844
From Other Territories—		
Spain	14,637	....
Egypt	....	6,065
British West Africa ..	779,513	....
Other countries on West Coast of Africa ..	80,847	....
Other countries of Africa	....	63,959
British East Africa ..	....	73,519
British India	527,433	3,159,575
Dutch East Indies ..	122,019	37,277
China	60,598	282,879
Other foreign countries ..	7,958	17,030
	5,183,525	5,287,205
Value £ ..	3,487,542	4,202,128

Total exports mds. ..10,470,730 cwts. Value £ 7,689,670

A very large quantity of oil is exported from France to other countries in Europe, United Kingdom and North and South America, especially to the United States. The prosperity of the trade depends upon the export of groundnut cake. During the recent war as the central powers were at war with it, most of the markets for the cake were cut off and consequently a large stock was held up in France and the slump caused thereby affected the groundnut trade in India and Gambia. There is no duty on oils exported into England. A very small quantity is pressed at Hull. On the other hand all the Continental powers allow a free passage for the oil-seeds but put a tax on oils. If British groundnuts are to be utilized by the British Empire not only must up-to-date presses be constructed but arrangements should also be made for the utilization of cake. Groundnut cake being one of the most nutritious of cattle feeds, and the richest cake in nitrogen and rich in carbohydrates and fats, it could be easily introduced into the country in preference to poorer cakes.

United Kingdom imported in 1913 the following quantities of nuts, oil and cake :—

		Tons.	
From India	..	32,000	cake.
		500	nuts.
Gambia	..	984.7	
Nigeria	..	9,338	
Senegal	..	103	
France	..	1,472	tons undecorticated.
		1,167	,, decorticated.
		39,450	cwts. oil.
Hamburg	..	144	tons nuts.
		9,273	cwts. oil.

Groundnut oil has been found to be one of the best vegetable oils used in the making of margarine. By hydrogenation process it can be hardened and its use in that state replaces the use of animal fats.

Since the War many British mills have begun to crush groundnuts. In 1917 about 137,758 tons were imported into the country.

The import of margarine from Holland and Denmark was steadily increasing from 1912 to 1916. In 1917 the consumption of margarine in the United Kingdom was very great. Nearly 5,500 to 6,000 tons of margarine were consumed in a week of which about 2,000 to 2,500 tons were imported.

The following table gives the quantities of margarine imported from Holland and Denmark between 1912 and 1916 :—

1912	.. ..	67,621	tons.
1913	.. ..	75,914	,,
1914	.. ..	76,461	,,
1915	.. ..	102,609	,,
1916	.. ..	137,643	,,

The conditions of trade in Europe have altered very much after the War. Before the Great War England was not purchasing much of groundnut. Indirectly she used to import oils, cakes and margarine from France and Germany. In 1924 England was next to France as a purchaser of groundnut and she is now encouraging the extension of its cultivation in her West African colonies. The following table gives the relative positions of various countries as purchasers on the European market before and after the War.

CHIEF IMPORTING COUNTRIES IN EUROPE.

Countries.	1911–13	1922	1924
France	553,370 tons.	557,145 tons.	606,743 tons.
United Kingdom (about)	50,000 ,,	66,833 ,,	100,989 ,,
Germany	78,111 ,,	68,197 ,,	73,740 ,,
Netherlands	54,849 ,,	43,883 ,,	66,307 ,,
Denmark	2,337 ,,	5,041 ,,	9,008 ,,
Italy	533 ,,	37,607 ,,	25,829 ,,

Germany has developed the groundnut pressing industry to an appreciable extent and is rapidly becoming a keen purchaser. Before the War she was purchasing about 78,000 tons of nuts and during the War she was cut off from her supplies. But by 1924 she almost revived her lost trade. Germany was purchasing mostly from West Africa and China.

Italy has developed a good market for groundnut. Denmark is now purchasing nearly four times the quantity she was buying before the War. Sweden and Norway purchase large quantities of oils. Argentina and Canada have also developed good markets for groundnut. A large quantity of Chinese groundnut makes its way into America in spite of heavy tariff and extensive local cultivation of the nut. Cheap labour in China enables the Chinese farmer to compete with his American comrade. Japan has also begun to import large quantities of groundnut. At the present time groundnut has become an important article of trade, and is supplying an appreciable amount of edible products. Its international importance and the ease with which it can be cultivated have drawn the attention of the farmers all over the tropics and the great demand has induced them to produce more. The future production and utilization of this oil seed depend upon better organization of capital, better shipping facilities, crushing industries and arrangements to utilize the by-products from the mills.

The growing demand for groundnut in Europe has given a great stimulus for its cultivation in the tropics. A brief survey of the growth of trade in groundnut in the important producing countries will show how the trade has developed as a result of the demand in the market. During the Great War when there was no demand from Europe, prices fell resulting in a great shrinkage of area under groundnut everywhere. The prosperity of the groundnut industry depends mostly upon the demand from Europe.

India.—The appearance of Indian nut in Europe dates from about 1840. But forty years later the export was still only 1,300 tons or only about 1 per cent of the total imports to France. In 1883 Bombay exported 29,791 tons of nuts whereas Madras exported only 5,855 tons. Between the years 1879 and 1884 the exports increased enormously.

TOTAL EXPORT FROM BRITISH INDIA.

1879	.. ..	1,273 tons.
1880	.. ..	2,421 ,,
1881	.. ..	94,190 ,,
1882	.. ..	18,665 ,,
1883	.. ..	13,287 ,,
1884	.. ..	35,647 ,,

By 1895-96 the areas under groundnut cultivation were 164,000 acres and 243,000 acres in Bombay and Madras respectively. Disease and deterioration gave a set-back to the industry and by 1899 the area under cultivation fell below 66,000 acres in Bombay. The introduction of nuts from Mozambique and Senegal having more oil and possessing greater productivity gave a fresh impetus to the cultivation of groundnut in 1900. A rapid extension of the crop followed and by 1914 nearly 2,100,000 acres were cropped with groundnut producing 749,000 tons of nut. During the War there was again a decline in trade and consequently also in the area under groundnut cultivation. But it is rapidly recapturing its original markets and has secured a good market in the country itself. Quite a large quantity of oil and cake is now being utilized in India.

The following table gives a brief summary of the area under cultivation and the actual areas under food grains and oil-seeds :—

Area of British India excluding major Indian States	1,164,009,000 acres.
Area available for cultivation	664,158,000 ,,
Actual area sown in 1925	225,849,000 ,,
Area under food grains	206,629,000 ,,
Area under oil-seeds	15,157,000 ,,
Area under groundnut	3,768,000 ,,

The actual area under oil-seeds in 1925 was only 5.9% of the total area under cultivation and this was distributed amongst the various oil-seeds as follows :—

Groundnut	3,768,000 tons.
Sesamum	3,410,000 ,,
Rape and mustard ..	3,089,000 ,,
Linseed	2,524,000 ,,

During 1925-26 the distribution of groundnut areas was as follows :—

Madras	2,598,609 acres.
Bombay	595,888 ,,
Central Provinces	59,686 ,,
Burma	498,587 ,,
United Provinces	14,410 ,,
Bengal	400 ,,
Behar	200 ,,

If we assume 600 lbs. to be the average yield per acre and Rs. 7 the price for 100 lbs. of nuts in pods, the value of the production during 1925 works up to very near £ 10,000,000.

I have merely indicated these figures to show how important a place groundnut occupies in the economics of the Indian cultivator.

The export trade is conducted through the following ports. A large quantity of nut produced in South India was exported to France through Pondicherry. But the improvement of the Madras harbour, the better wharfing facilities at Madras and the construction of subsidiary railway lines to Madras have diverted the trade from Pondicherry to Madras. At present the prosperity of the Madras port mostly depends upon its groundnut trade.

The export trade in 1923 was distributed amongst the important ports as follows :—

	Per cent.
Madras	67
Bombay	29
Calcutta	1
Rangoon	1
Other ports	2

And the exports were distributed among the various European countries in the following proportion :—

	Per cent.
France	67
Germany..	9
Italy	9
United Kingdom	4
Holland	5
Other countries	6

The percentage of Indian nut in the total imports of groundnut into France since 1913 is as follows:—

	Per cent.
1913	58
1914	58
1920	25
1921	26
1922	40

The price in Madras was Rs. 74 per 100 kilos equivalent to 110 Fr. at Marseilles in March 1922 but fell to Rs. 56 at the end of the year, and recovered again to Rs. 67 in March 1923.

Foreign export of oil from Madras port in 1913-14 was 2,800,000 gallons—mainly to Burma, Ceylon, Mauritius and Arabia. There was a coastwise export of nearly 2.3 million gallons of oil of which nearly 88 per cent went to Burma in 1922-23. A small quantity was imported by United Kingdom.

Oil exports to—

Ceylon	159,232	gallons.
Mauritius	107,308	,,
France	11,243	,,
Other countries	10,409	,,
	288,192	gallons.
Value £ ..	30,013	

In 1922-23 the foreign export of cake was 332,000 cwts. Ceylon takes it for manuring tea plantations. Before the War Germany used to consume 38 per cent of the cake exported from India. Java has begun to import large quantities for manuring sugarcane fields.

In 1923 the following quantities of groundnut cake were exported from India:—

United Kingdom	32,720	tons.
Ceylon	14,967	,,
Germany..	12,167	,,
Total including other countries	62,026	,,

Improved methods of cultivation of sugarcane and other crops are creating a good demand for cake for manuring purposes.

Burma.—There were about 258,000 acres round about Myingyan in the dry zone in 1923. The estimated yield was about 90,000 tons. Exports were 538,254 cwts. Burma imported from Madras 420,000 gallons of oil and 2,000 tons of nuts. Chief markets for Burmese nuts were France, Hongkong and Austria Hungary. It exported 45,000 tons of cake to United Kingdom. In 1916-17, 495,000 gallons of superior oil were exported. In 1912-18, 211,336 gallons were exported to Britain. Since then the trade has fallen to 76,836 gallons in 1918-19 and in 1922-23 only 92 gallons were exported to United Kingdom. The industry is very prosperous in Burma and the area under cultivation increased to about 498,587 acres in 1925.

Gambia.—Gambia is the oldest tropical British colony which is nearest to England. The harbour at Bathurst is the finest on the West African coast. The river is navigable for vessels with a draught of 18 ft. for about 120 miles inland and steamers drawing up to 24 ft. can enter the river at all states of the tide in safety. The prosperity of the colony with its 200,000 population depends upon agriculture. Its tropical climate and light soils are well suited for groundnut cultivation. The farmers grow the nuts and sell directly to the merchants or agents of manufacturers in France or England. There is no middleman here. The export in 1837 was 13,200 cwts. The average export for several years has been about 70,000 tons. The newly organized Agricultural Department is helping the farmers to grow new varieties of groundnut and other crops. The buying stations are all situated along the bank of the river or creeks. The growers bring their crops to these stations. They value the handsome French 5 Fr. pieces which they have known for many years and have a strong partiality for them. But they have been demonetized and sterling notes and alloy coins are now in circulation. The area is too large to be handled by the local population. Workmen from French Senegal used to work the land with the owners on a share basis. The completion of the Railway from French Soudan to the sea-board has enabled the French Soudanese to grow groundnuts in their homeland. Gambia has to face shortage of labour in future. Nearly 17,383 strange farmers consisting of Bambarras and Mauswonkos worked in Gambia in 1927. One-third of the area is grown by

Gambians, one-third by the strange farmers and one-third is brought in from produce in French Soudan. The completion of the French Railway is seriously menacing the prosperity of the colony. Not only have the strange farmers begun to cultivate their own lands but trade is being diverted to ports on French Railway.

Nigeria.—In 1923 the export was 23,000 tons, and in 1924 nearly 100,000 tons were exported. It is largely grown round about Kano within a radius of 100 miles. Kano which is 700 miles inland exported very little groundnut until it was tapped by the railway from the coast. More area could be put under this crop but there are no facilities for transport and a distance of hundred miles is considered long enough for carrying a good donkey load. Nuts are harvested, shelled by hand and carried to the market in goat-skin bags on donkeys. They are sold to the European or local merchants. The sale is by weight and for cash. Barter and sales by measure find no favour here.

The buying season, November to March, is very short. The nuts are bagged and kept in huge stacks near Kano. Some of the stacks contain 1,000 tons or more of nuts. They are removed by rail to Port Lagos or Baro on the river Niger. The river steamers transfer them to Burutu where they are shipped to Europe. Owing to the fine quality of Nigerian nuts and the good condition in which they arrive in Europe they command a premium over all other kinds. There is every hope of expansion of trade in this part. The fact that 100,000 tons of nuts are valued at £ 1,200,000 means that there is so much money in the hands of the Nigerian to buy articles of European manufacture. The development of the raw product helps both directly or indirectly to build up European trade.

Export in	1910 ..	was ..	994	tons.	
	1911 ..	.. ..	1,179	,,	
	1912 ..	.. ..	2,518	,,	
	1913 ..	.. ..	19,283	,,	
	1916-1918	.. ..	52,752	,,	
	1919-1921	.. ..	45,240	,,	
	1922-1924	.. ..	41,681	,,	
	1925 ..	.. ..	120,000	,,	(estimated.)

Senegal.—The trade in groundnut was first started here at Dakar in 1840—and next to India it now exports the largest quantity of nut. Large quantities of nut are produced in Senegal and the produce from

the upper reaches of the Niger also are brought down by the railway to the coast for export. The probable output in 1925 was 300,000 tons. The country is admirably governed and the people are kept well under control. Every encouragement is given to cultivate groundnut for a fair return. A moderate freight is charged on the Government Railways and there is strict governmental control over the trade.

The trade is served by four ports, Rufisque, St. Louis, Dakar and Kaolakh, but the Railway from Dakar to Kaolakh has practically killed Rufisque and St. Louis. But in commerce all Senegalese nuts are called Rufisque. Kaolakh is 70 miles from the sea on the Saloum river and ocean steamers can float up to 900 tons. They then proceed to Dakar to complete loading. It is not likely to extend cultivation in Senegal but greater quantities may be produced in French Soudan and exported through Senegal ports.

In 1840	..	..	1,210	kilos	were exported.
1841	..	..	70,000	,,	,, ,,
1845	..	..	187,717	,,	,, ,,
1850	..	..	2,600,272	,,	,, ,,
1855	..	..	4,462,334	,,	,, ,,

The trade gradually expanded and in spite of other countries competing in the market Senegal exported the largest quantity to France.

In 1882 the exports were 83,000 tons but they gradually fell down to 26,500 tons in 1886. Since then there has been a steady increase in the exports. It reached 80,000 tons again in 1897 and improved rapidly.

In 1898	to	103,000	tons.
1899	,,	110,000	,,
1900	,,	137,000	,,

In 1925 the export figures had reached 300,000 tons. The gradual displacement of animal fats by vegetable fats and oils in Europe is largely responsible for this increase in trade. The shortage of butter and the increased consumption of margarine in the manufacture of which groundnut oil plays an important part are both responsible for the greater consumption of groundnut. As the nuts are shipped in shell they arrive in Europe in good condition and fetch high prices. But recently methods have been discovered of refining the oils pressed out of shelled nuts. In future the West

African trade is likely to be affected adversely if large quantities continue to be exported to Europe from India and the East.

United States.—For over a hundred years groundnut was grown only as a garden crop. In 1869 land that did not pay for tobacco was put under it. In 1874 its cultivation spread in Virginia and about 225,450 bushels were produced. In 1882, 382,616 bushels were produced. Large areas are now under this crop competing with cotton in several places and filling up the place of cotton where the latter is badly attacked by boll-worm.

The following table shows clearly how the groundnut is competing with cotton as a money crop:—

In 1918.	Value per acre in dollars. Cotton.	Ground nut.
Virginia	.. 71.55	85.2
N. Carolina ..	.. 68.96	93.1
S. Carolina ..	.. 64.86	113.4
Georgia	.. 51.70	44.8
Florida	.. 33.54	52.3
Alabama ..	.. 43.20	33.0
Mississippi ..	.. 51.43	44.7
Louisiana ..	.. 44.28	43.9
Texas	.. 31.02	22.6
Arkansas ..	.. 43.09	45.7
Tennessee ..	.. 44.86	67.2
Missouri	.. 58.05	96.0
Oklahoma ..	.. 21.68	48.1

It was not a commercial crop till 1870 and till 1897 its importance was not marked.

Large quantities of nuts were imported into the States from Africa. To encourage cultivation in the States and to protect the industry heavy taxation was levied on imports. The trade as a consequence diminished rapidly. There was practically no import of groundnut except small quantities from Japan and Spain. But of late cheap labour in China is enabling the Chinese farmer to compete with his American comrade in spite of the tariff wall.

Imports in 1865-1870 ..	6,522,844	lbs. undecorticated nuts.
	391,006	,, decorticated nuts.
Imports in 1891-1897 ...	149,672	,, undecorticated nuts.
	21,658	,, decorticated nuts.
1897 ..	138,102	,, undecorticated nuts.
	1,000	,, decorticated nuts.

Since 1897 the extension has been very rapid. In scarcely 20 years' time the area under the crop expanded so rapidly that the production in 1918 was estimated at 53,000,000 bushels valued at $ 100,000,000. The falling off of cotton in large tracts placed the planters and oil millers in a precarious condition. Planters had no cash crop and the millers had no seed to crush. But the spread of groundnut has solved the problem by providing the planter with money and the miller with seed to crush for oil.

In South Alabama where cotton has been the king of crops from very early times in the history of that colony the advent of the boll-weevil turned colonists' attention to peanut. The yield from the crop was so great that the citizens of enterprise in Alabama, erected a monument to the memory of the boll-weevil, on one of their main streets.

In the United States not only are large quantities taken and roasted as salted nuts but also utilized in the manufacture of peanut butter, peanut oil and meal. In 1919 one manufacturer alone produced 6,000,000 lbs. of peanut butter. There are dozens of large factories and hundreds of smaller ones. Six to eight million bushels were used for making peanut butter. To check the large importation of oil from Europe the crushing industry is now being started on a large scale. In 1920 alone 386,097 tons of nuts were produced on 494,000 h.a. Some quantity of oil is now exported even to Norway and Sweden.

China.—In China large quantities are produced in the coastal provinces and exported to France. China is seriously competing with U. S. A. while the cost of production in U. S. A. is said to be $ 140 per ton it is only 100 to 110 dollars in China. It exports a large quantity to Australia. In 1921 the crop of China was estimated at 324,900 short tons. Of these 35 per cent to 40 per cent were exported to Europe. Canton is the chief port for exporting groundnuts. Very large quantities of groundnut-cake are used in South China for manuring mulberry trees.

Java.—In Java and other Dutch possessions larger areas are being cultivated now both for oil and for the cake to manure sugar-cane fields. But the exports are falling off from 60,282,300 lbs. in 1911—13 to 39,585,000 lbs. in 1924. Probably a larger quantity is being utilized for manuring canes.

Australia.—At present China is sending the requirements of Australia. The Agricultural Departments of New South Wales and Queensland are trying to cultivate better grades of nuts and their attempts have been successful.

A review of the conditions of production and the sea-borne trade of the various countries shows that groundnut has become an important article of trade. This is truly an age of discovery. The mind of man has led him on to newer and yet newer discoveries and has constantly brought to light unknown properties and qualities in many a natural product. Through investigation and research various articles of food that were unknown to the civilized world for centuries past have now been discovered and they are adding largely to the happiness of the world. The possibilities of groundnut are still great. Till now it was the demand from Europe that gave the impetus to its extended cultivation. But a larger consumption in the countries of production would seriously curtail the supplies to Europe, and a keener competition on the market will necessarily raise the present market value of the nut. Higher prices and greater demand will give a much greater impetus to its more extensive cultivation than has been done before. A prosperous trade in groundnut would in its turn help in the growth of a better fed and better clad peasantry in the tropics who would be in a position to withstand the ravages of tropical diseases. It is truly amazing to note that a plant growing in a far off country sunk in obscurity for centuries past has been responsible for an appreciable addition to the happiness of quite a large section of humanity in a remarkably short time in the history of nations.

SELECTIONS

Field Propagation of Cotton by means of Grafts

Grafting as a method of reproducing cotton asexually first received the attention of the writer in 1930. The results secured from these earlier trials demonstrated the practicability of grafting cotton under greenhouse conditions. The present report gives the results of a grafting experiment conducted during the fall of 1930 to determine the feasibility of grafting cotton plants under field conditions.

The Lone Star variety of cotton was used in this test and the plants had already matured bolls before the grafting was commenced. The saddle-graft method was used on all plants and the individual grafts were made with the minimum lapse of time between cutting the scions and placing them. The stocks remained in the soil with their roots undisturbed in each case.

The field grafting was done on September 18, 19, 21 and 22, under a schedule that provided for work from 1 to 10 p.m. for two of the days, and from 4 to 11 a.m. for the others. A 500-watt lamp was used to illuminate the field for work during darkness. By distributing the grafting throughout the day a wider range of field conditions was introduced. The most important variable was the temperature, which ranged from 68 to 93°F.

After the grafts were completed, they were allowed to remain in the field undisturbed for approximately thirty days. During the development of the unions, the average temperature was 72°F. with an average daily fluctuation of 22°F. In making the final observation, only those grafts that had started stem growth and withstood considerable pressure after the paraffin and twine were removed were considered successful. A total of 220 grafts was made and 87.2 per cent of them were successful. Also the percentage of successful grafts increased with each additional day's experience. The percentages of successful grafts for September 18, 19, 21 and 22 were 73.3, 88.8, 90.0 and 100.0 respectively. It is quite evident from the results secured that cotton can be grafted successfully under a wide range of field temperatures.—H. E. Rea, *Texas Agricultural Experiment Station, Sub-Station No. 5, Temple, Texas,—Plant Physiology*, Vol. 8, No. 1.

A Note on Tung Oil

By E. S. Clayton, H.D.A. Senior Experimentalist

The tung oil tree (*Aleurites fordii*) is a native of central and western China, which country, until recent years, was the only one in the world growing the tree commercially. Steps have been taken to test the possibilities of the tung oil tree in Australia, and the New South Wales Department of Agriculture is experimenting with it and has distributed a considerable number of seeds to private growers with the idea of testing the suitability of the tree to various parts of the Commonwealth.

There are no large commercial groves of tung oil trees yet in full production and selling commercial oil in New South Wales, therefore no definite figures regarding yields, prices, and expectation are quoted.

Caution Urged

It is probable that when the districts most suited to commercial production have been definitely proved appreciable quantities of tung oil may be produced here, and it is possible that an export trade in the oil could be established. At present, however, prospective growers are advised that while the tree is worth testing in the better rainfall districts along the coast and tablelands the industry is still in the experimental stages of development, and consequently the planting out at the present time of large commercial areas is not advised where there is any doubt as to the suitability of the climate or soil.

Climatic and Soil Requirements

An annual rainfall of not less than 28 or 30 inches seems to be required, heavier rainfall, of course, being preferable. A hot summer and a fairly cold winter seem to suit *Aleurites fordii*. In China, where it thrives best, although snow is often present in winter there is generally only about 4 degrees of frost. The trees do not appear to do well where more than 12 or 13 degrees of frost occurs. On the other hand, if the winter is not sufficiently cold to give the tree a definite resting period and cause it to shed its leaves the yield is not likely to be satisfactory.

The tree is very adaptable so far as soils are concerned, growing well on most classes of soil. It, however, prefers a slightly acid soil and does not thrive where the surface soils contain much lime. A deep soil of a sandy or light nature well supplied with organic matter is very suitable, but the tree grows well on any well-drained fertile soil.

Uses of Tung Oil

Tung oil is an important constituent of water-proof varnishes and paint liquids and is imported by the United States, Great Britain,

Australia and other countries from China. The oil is also used as an ingredient for dressing leather and for varnishing furniture and floors. These are the main uses, there being many other minor purposes for which tung oil is used.—*Agricultural Gazette of New South Wales*, Vol. XLIV, Part 2.

Notes on Tobacco Cultivation

Climate and soil are the most important factors governing the successful cultivation of tobacco.

Extremes of temperature, uneven distribution of rainfall, lower relative humidity owing to continued bright sunshine and drying winds, tend to prevent even growth of tobacco, with the result that it is comparatively poor in texture and smoking quality. Judicious irrigation may, to some extent, alleviate the condition of uneven rainfall, but irrigation cannot be regarded as other than supplementary to natural climate.

The other essential condition for the production of good quality tobacco is suitable soil.

The most suitable soil for tobacco culture is a fine-textured, greyish-coloured sand or sandy loam, fairly deep and naturally well-drained, with a friable sandy clay subsoil. It is generally recognized that the more humus a soil contains the more suitable it is for the production of bright flue-cured tobacco of good quality, provided that the rainfall is adequate and evenly distributed.

Analyses of soils from tobacco-growing areas in Australia show that in many cases the proportion of silt and clay is too high for the production of tobacco with a good smoking aroma.

Analysis shows that 1,000 lbs. of cured leaf removes 80 lbs. of potash, 60 lbs. of nitrogen, 40 lbs. of lime, and 16 lbs. of phosphoric acid from the soil. The soil, therefore, must be able to supply the plant with the elements necessary for its growth in such a form as to be most suitable for the development of good quality leaf. Using light sandy soils, it is obvious that most of the elements must be supplied artificially as fertilizers.

The food substances in the fertilizers are dissolved in soil water and absorbed by the root system of the plant, and consequently it is essential that the root system should be well developed. Good tilth and satisfactory rainfall determine the capacity of the root system.

Water is evaporated from the plant and the food substances are left behind to be used in building up plant tissues. If the atmosphere is humid, the intensity of sunlight is reduced and so is evaporation, and under these conditions the plant-food elements absorbed are used up at a normal

rate. If the plant is grown in rich soil under intense light, high temperatures, and a dry atmosphere, evaporation is rapid and the accumulation of food supplies exceed their normal use. Such leaf is likely to be coarse or tough, and to have an objectionable smoking quality.

Good tilth is necessary to ensure a good stand of plants from the first, and to ensure steady growth. Seed beds should be rich and well-drained protected from cold winds, but exposed to sunshine. It is advantageous, and essential in some areas, to sterilize the soil by heat in order to kill weed seeds and disease-causing organisms.

Transplanting should be undertaken as early as weather conditions permit, the plants should be uniform in size, and, if the weather is hot, they should be protected by covering with paper hoods until they are established.

One man can satisfactorily handle only 5 acres of tobacco, and even with this area assistance will be needed at harvest and during curing.

"Topping" is the process of removing the flower head and the small top leaves, so that on an average twelve or fourteen good leaves (not counting the bottom trashy ones) are left on the plant. The trash leaves should be removed at the same time, and this operation is known as "priming". Shortly after topping lateral shoots must be removed, and this is known as "suckering".

Usually about four weeks after topping the bottom leaves begin to mature, and this is indicated by a change of colour from dark to pale green or by yellow mottling. The more satisfactory method of harvesting for curing is that of taking individual leaves of the same stage of maturity.

Curing does not make good tobacco out of poor leaf, but, if properly done, it fixes and further develops quality already established during growth.

Flue-curing is a relatively rapid process, suitable for bright types of tobacco grown on light sandy soil. For tobacco of high nitrogen content produced on heavier soils the slower process of fire-curing is more likely to yield a good final product.

After curing the leaf is ordered (so that it may be bulked without damage) by remoistening until, when it is squeezed in the hand, there is a slight cracking in the lateral veins. It is then bulked, with the bottom layer well off the ground, covered with bags and weighted down to prevent drying. After good-coloured leaf has been bulked for about five weeks, it is ready for grading and baling.

There is a demand for a limited supply of Burley tobacco, which requires a soil reasonably rich in lime, nitrogen, potash and phosphoric

acid. It should be grown fairly large, the leaves should have good body, and they should not yellow prematurely in the field. It must be air-cured on the stalk in a barn which will give protection from wind and allow regulation of the rate of colouring and drying.

From seed bed to harvest the tobacco-grower has to contend with diseases and insect pests of some kind. Downy mildew (blue mould) is the most important disease in southern areas, while damping off and frog-eye leaf spot are worst in northern areas.

Damping-off is controlled by thoroughly sterilizing the seed bed soil by steam, burning, or drenching with formaldehyde.

Frog-eye leaf spot is being investigated: but, in the meantime, growers are recommended to avoid planting seedlings showing spots of any kind, to spray seed-beds with Bordeaux mixture at intervals of from five to ten days according to weather conditions, and to remove infected sand leaves as early as possible.

In bulk the moisture content of the leaf must be kept under control, usually about 14 per cent, to avoid the development of moulds, which rapidly give a musty odour to the bulk.

During the growing season, insect pests, especially cutworms, budworms, etc., must be controlled by baiting or dusting.—*The Tropical Agriculturist*, Vol. LXXX, No. 3.

Some Methods of Grafting

To the ancients the phenomenon of grafting and budding was a very misunderstood subject. Many wild claims were made even by prominent men. Virgil speaks of a plum tree that bore apples after having been grafted. Martial advised the grafting of the cherry on the poplar. Columella in a like manner claims that the olive should be grafted on the fig. Other extravagant claims include the following: that the orange grafted on the holly wood ensure the former being acclimatised to the open woods, and that the vine grafted on to the walnut would enable the grapes to contain oil.

These wild claims, however, indicate that the art of grafting was recognized, and to some extent it must have been practised, but it is only recently that the absurdity and the idea that man was degrading Nature by such practices, have been mostly eliminated.

The scope of grafting is enormous—a fact not realized by many people. Together with budding, it is employed on nearly all our orchard trees, though to some extent walnuts, plums and loquats are propagated

by cuttings. Grape vines in the main viticultural countries also require to be grafted. One would naturally assume that a tree on its own roots would flourish much better than when grafted on to another's. Perhaps it would, but there are other factors to be considered. The following are some of the more important:—

1. Grafting is used to perpetuate a variety of fruit. Let us take an example. The "Granny Smith" apple tree was noticed many years ago growing in New South Wales. Its qualities were outstanding. Since then many thousands of trees have been derived from it. The seeds very rarely come true to type, and in the early stages of propagation, cuttings would be a more wasteful way of perpetuation.

The navel orange furnishes another excellent example of the perpetuation of a variety. The navel orange is seedless, and this fact is important, for without the process of grafting and budding, and the use of cuttings (which is a slow means of propagation), it would be impossible to perpetuate the variety.

Brazil is the home of this orange, where it arose as a "sport". It possessed so many obvious advantages over the other varieties of oranges that for its commercial perpetuation a rapid and sure means of propagation was desired. The means, rapid, easy, and reliable, was at hand—budding—a form of grafting in which only a single bud, with or without adhering wood, was used as the scion—the stock, the rough lemon or citron. Since then, in a comparatively few years the navel orange has spread over the world, and forms to-day one of the most common and popular varieties of orange.

Most of our varieties of fruit trees are budded or grafted—they are kept true to name and variant factors are kept at a minimum. When these variant factors do arise, possessing exceptional qualities, then they, too, can be perpetuated. The varieties of navel oranges again form examples.

2. Grafting is employed also to mitigate the ravages of disease—particularly for such fruits as the apple, citrus, and the grape vine. Most apples in Australia are grafted on to "Northern Spy" stocks for the reason that this variety of apple is very resistant to the root attack of Woolly Aphis (*Shizoneura lanigera*).

European grape vines are grafted in most other countries of the world on to American varieties. The reason being to prevent the practical extinction of the varieties of *Vitus vinifera* due to the ravages of the terrible disease known as Phylloxera, caused by a species of aphis known as *P. vastatrix*. This disease was introduced into France during the last

century on stocks imported from America to minimize the effects of the fungus disease known as Powdery Mildew (*Oidium*). The ultimate result was the complete annihilation of the European vines, except in some isolated areas. This meant that fresh plantings had to be made of grafted vines and cuttings—all on American stocks which are very resistant to the disease.

Vine-growers in Western Australia are particularly fortunate, for this dread disease is not present.

3. Grafting may modify the stature of the plant. One may desire dwarf trees, and these may be obtained by using for apples the stock known as "Paradise," and for pears, quince stocks.

4. Grafting is also very useful, in many cases imperative for the adaptation of varieties of fruit trees to various soil types. It is common knowledge that the various kinds of fruit trees have individual tastes concerning location, soil, and climate, and grafting is used to modify these preferences. Plum stocks are used for peaches on heavy lands, and *vice versa*, peach stocks for plums on light lands. In chalky districts in England almond stocks are used for apricots. These are a few examples only of stock modification of varietal preferences.

5. Grafting including budding, is very useful in nurseries to accelerate the fruitfulness of new varieties of fruits under test. One would have to wait a considerable time for a seedling to fruit naturally, but by using grafts and buds we are able to secure results in a very short space of time.

Grafting, although not a new method, may be freshly adapted to meet varying conditions of soils, and to change over unprofitable varieties of fruit trees to those better suited to climatic and market requirements.

The terms used in grafting will be understood by most, but for those not so conversant a few explanations will be necessary.

A graft is composed of two components—one, the scion, the portion of the plant one desires to propagate, whether bud, spur, terminal shoot, or matured wood one season old, and the other the stock, or host plant. The stock, whether root, trunk, or limb, nourishes the scion if the union is congenial, permitting its growth and the retention of its varietal characters.

However, these varietal characters may be subject to modifications, as shown by recent research. Certain modifications one may remember, such as (*a*) dwarfness, (*b*) the adaptive nature of certain stocks for soil types, (*c*) increased vigour, and (*d*) many other modifications not usually noticed, but nevertheless playing very important parts.

Many fertilizer experiments on fruit trees have been failures, due almost entirely to the non-standardization of stocks affecting the standardized scions, leading to results at once misleading and meaningless, even though carried out for thirty or forty years.

For most practical reasons, however, the propagation is true to type wherever the union of stock and scion is congenial. The scion is inserted into the stock by means, which we will later explain, and commences to grow if the conditions are favourable. These can be enumerated:—

(1) The contact between scion and stock must be perfect so that the cambiums are in close proximity. The cambium is that part of the plant that separates the xylem, wood, or water conducting and skeletel system of the tree from the phloem, or food conducting system. In young wood this cambium has the wonderful power of regeneration, furnishing wood cells on the inside and phloem on the outside. The cells occurring in the cambium are analogous to those found in the growing points of shoot or root. They are actively alive and are capable of fresh growth. It is now obvious that for a successful union these portions of our components must be in close contact so that by the rapid production of callous tissue the union is initiated before the scion is subject to the hot rays of the sun and desiccating winds.

(2) There must be a close affinity between stock and scion, *i.e.*, there must be close relationship botanically, though exceptions occur as they do in most rules. The flowering plants are divided into two sections—the Monocotyledenæ and Dicotyledenæ: the former including the cereals and grasses and the other our fruit trees. As one easily sees there is no affinity between a grass and a fruit tree. The Dicotyledenæ is divided again into families, *viz.*, the Rhamnales includes the grape vine and the Rosales includes the apple and pear trees. Therefore, the families are groups of plants possessing characters differing widely from each other, and are again lacking in affinity. The families are further divided into genera, each possessing allied features—for instance there are two genera in Rhamnales, of which one is the Vitaceæ, and seven in the Rosales. The genera then confined to a family are more closely connected, but still it is remarkably difficult for inter-grafting to take place except in rare instances. The genera are further divided into species. In the genus Vitaceæ we have, amongst others, the following species:—

(*a*) *Vitus vinifera*, the European grape vine as grown here.
(*b*) *V. labrusca* }
(*c*) *V. riparia* } American vines.
(*d*) *V. rupistris* }

Here there is fairly close affinity, but not so close as one would expect. The American vines form stock of varying utility, and the unions are often bad. Even amongst a genus the affinities of species for each other may still be poor. The change over to American stocks in other parts of the world entailed a tremendous amount of research work and many resultant failures and still the lives of the grafted vines are comparatively short.

The species are again divided into varieties. There are the Muscats, the Malagas, the Sultanas, the Red Princess, the Ohanez and thousands of others. Usually the affinities between these varieties are quite good and grafting is easily accomplished, but again we find that these varieties have individual tastes for soil, location, and climate and much remains to be done to render desired varieties successful on stocks that in certain soils and locations on their own roots would be failures or else only partial successes.

For successful grafting a close affinity is necessary and one finds it chiefly amongst varieties where, even there, it may still be a variable factor. The quince and loquat furnish an example of close affinity where the members of the union do not belong to the same genus.

(3) *Season.*—The usual time for grafting is in the spring at leaf-burst when the soil is moist and conditions ideal. The roots had commenced activity weeks before in preparation for the work ahead of them. The condition of the tree at this stage can be compared to a greyhound straining at the leash—all eagerness for the chase. The cambial tissues have the reserves of last year's growth and the early preparation of water and mineral requirements by the roots behind them, and they are eager and ready for the moment to commence growth. It is not surprising then, that this is the ideal time for grafting, where the unions rapidly callous and growth commences, before the severe conditions of summer make themselves felt.

Other forms of grafting can be done at various times during active growth, *viz.*, herbaceous grafting.

Budding can be done either in the spring or December-January for deciduous trees, or in the early autumn for citrus trees. The dormant buds give much better results.

(4) *Implements and Materials.*—The implement, of course, can do much to make or mar a successful graft, even when all the other factors have been favourable.

The grafting knife must be strong, finely bladed and possessing a keen edge. All cuts must be smooth and clean, thus ensuring a rapid callousing of the wounds. The mallet, or—as is sometimes used when

much grafting is to be done—a wooden club, retained on the wrist by means of a leather band, must be strong and not too heavy.

The implement used for cleft grafting consists of:—

(*a*) Handle.

(*b*) Blade—the extended portion forming a stout and sharp cutting edge.

(*c*) The distal extremity is curved upwards in the form of a wedge.

This tool is very convenient, the cutting edge, by the force of the mallet, forms the cleft; when withdrawn and the wedge inserted, one is able to shape the stock, insert the grafts and when the wedge is withdrawn the scions are held firmly in position.

All implements including saws, etc., must be kept clean and in good condition, for when one stops to consider one realizes that a clean, healthy wound heals much more readily than does a dirty, ragged one.

The graft when made must be protected from the weather, otherwise drying winds would promptly end all chances of success. Therefore, all the wounds must be amply protected and this is done by the use of grafting wax, waxed calico or muslin, or grafting clay.

A good grafting wax can be made from the following formula:—Resin, 2 lb.; beeswax, 1 lb.; tallow, 1 lb. This is applied by means of a brush—hot, but not too hot—over all the wounds.

The waxed cloth may be made by passing the strips of cloth from two rollers through the hot prepared wax, and, by means of boards, stripping off the surplus. When dried it can be rolled and used when required.

The grafting clay is sometimes utilized, but it is more used when one is grafting vines. A useful formula is as follows: Clay, 2 parts; rotted horse manure, 1 part; *plus* a little chopped hair.

(5) *Treatment.*—The care meted out to the grafts is usually meagre. They reward careful attention by well-directed growth, free from the competition of water shoots that often on vigorous stocks arise in profusion.

It is necessary—

(*a*) To bind the grafts, especially in windy locations, to stakes attached either to the limbs or fixed in the soil. Many losses occur every year that can be directly attributed to the force of the wind on unstaked grafts. The first callousing is, of course, composed of soft tissues that possess no strength of cohesion. Later the strength that very seldom becomes a weakness in the tree is developed.

(*b*) That the raffia or bindings used in tying the grafts must be removed before they become a menace in constricting the union as the graft commences vigorous growth. Many unions are ruined in this way.

(*c*) That water shoots and competing growths must be removed, otherwise the flow of sap is diverted to the stronger channels to the detriment of the graft. In some instances, it is wise to retain such growths in order to subdue to some extent too vigorous scions, whose rate of growth is out of proportion to the rate of strength developed in the union.

This restraint on the scion can be applied also by judicious pinching out of the growing point. The rate of growth is checked and time is thus given for strength to develop in the union.

The care of the graft is amply repaid by strong well-directed growth capable of easy manipulation, and in the following season rewarding the operator by increased fruit production. Alas, too often is the graft left to struggle, unaided, by itself, and in the event of failure—only too common—the system, and not the operator, is to be roundly condemned, and, therefore, useless.

The preceding are, briefly, some of the factors affecting grafting. The subject is extremely large, and the scope of this article does not permit us to further enlarge on this particularly fascinating subject.

The following is a broad outline of the systems of grafting commonly used. We have done some considerable work on such methods of grafting that apply to the grape vine, the fig, the apple, citrus and stone fruits.

METHOD OF GRAFTING.

I. Bud grafting or budding.
II. Grafting proper.
III. Bridge grafting and inarching.

I. BUD GRAFTING.

(*a*) *Shield Budding.*—The name "shield" is derived from the resemblance of the cut bud to the mediaeval shield. With deciduous trees well-developed buds are cut from healthy shoots during the months of December, January and February. By means of a T-shaped cut just reaching to the wood they are inserted into the stock and firmly bound with raffia or wool. This can only be successfuliy accomplished when the so-called bark comes easily away from the wood. The ligatures require to be removed 8 to 14 days after the operation, and the bud remains dormant until the following spring, when the stock above the bud is removed.

(*b*) *Flute Budding.*—This method can be used for fig and walnut trees. The bud is obtained by two parallel and two perpendicular cuts into the bark; in the former case about half-an-inch below and above the bud, and in the latter about the same distance from the sides of the bud, which can then be easily detached. The shape is now fluted; hence the name.

The bud on the stock where the scion is to be received is cut similarly and removed. The exchange can now be accomplished, and the union is bound firmly with wool or raffia, care being taken not to cover or injure the bud proper. Flute budding is usually recommended in the spring for figs. Somewhat later in December, it is used in other parts of the world for grape vines.

II. Grafting Proper.

There are many systems in vogue but the following are in general use under most conditions in Western Australia. They will be discussed in detail later.

(*a*) *Whip and Tongue Grafting.*—This is, perhaps, the graft in most common use. It is particularly adapted for stocks of small diameters, and is extensively used by nurserymen for such trees as the apple and pear. It can also be applied by the orchardist to nearly all deciduous fruit trees.

(*b*) *Strap Grafting.*—This form of grafting is an ingenious device for the grafting of stocks of large diameters, ensuring a quick and sure covering of the stump. Strap grafting is, perhaps, the most efficient system we possess, and can be applied to apple, pear and stone fruit trees.

(*c*) *Cleft Grafting.*—Presenting such ease of operation, cleft grafting is used extensively in the field for such fruits as apple, pear, stone fruits, figs, grape vines, mulberries and citrus.

(*d*) *Bark Grafting.*—This method of grafting, with several modifications, is also commonly used for such fruits as apple, pear, stone fruits, mulberries, figs and citrus.

(*e*) *Inlaying.*—As will be seen later, inlaying present features that appear to be admirably suited to the grafting of grape vines.

(*f*) *Herbaceous Grafting.*—The green shoots are used in this form of grafting. It is extensively used in European countries for grape vines, and is seen here practised by Slav workers in the Swan and Spearwood districts.

(*g*) *Bottle Grafting.*—The late Mr. Catton Grasby introduced this graft from abroad. Though tedious in maintenance, this system is an admirable and sure method of overhead working the grape vine.

III. Inarching.

Skin grafting and blood transfusions as practised by the surgeon have interesting corollaries in the realm of the horticulturist. The system of inarching seeks to transfuse new life into a tree weakened by root injuries, and the following method:

(*h*) *Bridge Grafting.*—Seeks to correct trunk wounds too large to deal with in Nature's way.

Grafting the Grape Vine.

Grafting to many vignerons does not appear to be worth the trouble, nor to be worth while. We assure them that it is, and that returns are obtained much faster than from fresh plantings. Usually, it is most difficult to secure vigorous growth from initial plantings in situations where old vines have stood for years, unless the soil is removed and fresh good soil substituted.

The stock method of grafting is the cleft graft noted for the ease and comparative success of its operation.

It is performed in the spring when the shoots on the stock are several inches in length and the sap pressure somewhat reduced. The scions are obtained from those stored during the winter months in moist sand. The stock is cut with the saw on a level, or a few inches above, the surface of the ground. The cleft grafting implement is placed diametrically across the stump and the force of the hammer or mallet ensures the splitting of the stump to a distance of three inches, when the implement is withdrawn and the wedge-like distal extremity is inserted into the cleft. While still in position, the cleft on each side is cut, starting from an inch to an inch and one half from the top, in a triangular fashion, being careful that the cuts are clean and smooth, not too deep nor yet removing too much wood.

The two scions are now selected—firm, healthy, dormant canes, consisting of one to two buds each. They are given a slanting cut on one side through the pith. On the other side a cut is now given to expose the cambium, not through the pith, to form a triangular wedge that fits exactly the excavations made in the stock.

The two scions are now inserted, care being taken that they fit perfectly, and that the cambial layers of stock and scion are in close and intimate contact. The wedge is carefully withdrawn and the scions bound with raffia or twine.

It is preferable to bind the grafts, otherwise dislodgements are possible, ruining all hopes of success. After tying grafting clay is pressed firmly and carefully over the stump to cover the surface of the wound, though this can be dispensed with. Soil is now heaped over the graft to a height of 15 inches to prevent desiccation and to permit the union to take place. If the soil is very clayey, it is advisable to finish the heaping process with a layer of sand, otherwise the clay may become caked, and the growth of the scions have difficulty in growing through it.

The scions commence growth amidst a profusion of suckers and water shoots, and care must be exercised that the scion is not permitted to play a minor rôle subservient to such growths. Sometimes if the scion is growing too rapidly a weakness may develop at the union, and in this case it would be wise to allow some sucker growth to take place, or else to pinch out the growing points of the scion shoots.

The cleft graft, however, is difficult when it is desirous of grafting twisted stocks, and the following method overcomes this:

Grafting by Inlaying.—The stock is cut down in a similar manner to that described under cleft-grafting. The implement used to form the inlay, parallel to the long axis of the stock, is a half inch triangular gouge that forms a clean triangularly-shaped wound an inch or so in length and from a quarter to a half-inch in depth, on the most projecting side of the stock. If the stock is straight, the inlay is made anywhere just above ground level.

The scion, 14 to 18 inches in length, is cut on one side to fit the inlay, by cutting to the pith, to meet another cut exposing the cambial layer just below the second bud from the top. A hole is then dug to take the length of scion and the graft is secured by firmly tying with raffia. Care, of course, must be taken that the cambial regions of stock and scion are in close and firm contact. The earth is heaped over the stump as for the cleft-graft.

The scions for this graft need not necessarily be dormant: a slight bud burst has been successfully used in a Caversham vineyard. Six vines were grafted—five by the above method, and the other by adapting the cleft of the cleft-graft to take the place of the inlay. They were all successful, making vigorous growth that compared more than favourably with neighbouring vines cleft-grafted. The stocks used were muscats, and the scions currants. No misses were recorded—a fault that sometimes occurs with cleft-grafting even if performed in a capable manner.

The following, I think, are some advantages that this system of grafting suggests:—

(1) It permits knotted and twisted stumps to be grafted.

(2) On weak-growing vines the stock acts as a nurse, nourishing the scion until it can establish itself on its own roots. The deep planting of the scion enables roots to be formed out of danger from the reach of cultivating implements.

(3) The deep planting of the scion enables it to withstand drying conditions better, the moist subsoil being analogous to the bottle of the bottle graft, keeping the scion moist until the union takes place.

Really the scion starts life as a cutting, then as the union is consummated, as a graft, to be followed later by the phase of symbiotic existence, and then, ultimately, if required, to establish itself on its own roots.

(4) The scion being so firmly held in the soil proves more difficult to dislodge.

(5) If it is intended that the scion should not establish itself on its own roots, the lower portions can be removed when the union has become safe enough for the purpose.

Bottle Grafting.

This curious method of grafting can be used at any season of the year, when partially or wholly matured wood is available. It is the only sure means of overhead grafting that we possess, though we have been successful in some overhead cleft-graft carefully waxed.

Instead of the moist subsoil, the bottle, filled with water enables the union to take place before drying conditions eventuate to kill the scion. In all cases observed, contrary to deciduous fruit-tree grafting, the bud burst precedes the callousing over of the union, and it is thus why the overhead working of the vine is so difficult.

The part of the stock to receive the scion is obtained usually on a spur, as close as possible to the main arm.

The scion varies in length from 8 to 10 inches depending upon the depth of the container used. A slanting cut just below the topmost two buds is made reaching to the pith, pointing to the lower extremity of the scion. The edge of the lip is on the outside for a quarter to a half-inch cut to a cambial layer. The stock is now treated in the reverse manner, care being taken to ensure that the lower extremity of the scion will be pointing downwards. The lip of the stock is treated in the same way as that of the scion and the graft is effected by bending back both stock and scion. A firm intimate contact is essential.

The graft is firmly bound with raffia, and a bottle or any container with a narrow neck, permitting a minimum amount of evaporation, is to be used. It is filled with water and fitted over the hanging portion of the scion and fixed securely.

The only maintenance necessary is that the water level should never recede beyond the end of the scion.

The Bottle Graft.—Muscat on Black St. Peter, grafted in March 1931, although in an inferior position made good growth, and ripened two bunches of fruit. The lower extremity was kept in water until the union was effected. It is now dead and can be removed.

In a suburban garden we obtained excellent results from this graft by performing it in March. In the following spring a strong healthy

growth ensued, and at the end of November the lower portion of the scion was found to be dead. The union was excellent.

This method suggests, if the vine is to be commercially top-worked, that two spurs, as near as possible to the trunk, should be grafted. From these two grafts subsidiary main arms could be established that when developed enough could take the place of the old. During this time the crop of the vine has not been seriously interfered with.

The method involved in bottle grafting is simple and most efficient. The chief criticism is that a fair amount of attention is required filling the containers during the summer months when the vigneron is working at full pressure.

Herbaceous Grafting.

We have seen excellent examples of this form of grafting.

The vigorously growing cane, when it attains the diameter of one's little finger, is cut with a short, slanting cut about an inch from the basal bud. The scion approximating to the same thickness and at the same stage of maturity is cut in a similar way, leaving only one bud, and placed to fit exactly over the exposed surface of the stock. The graft is then bound with wool or rubber bands. A considerable degree of judgment is required in selecting both stock and scion.

We are not in favour of the method adopted in the grape districts, where the stock, usually old, is cut down during the winter months a foot or so from the ground. During the spring a water shoot if one is lucky —springs from the stump, and that is the one selected for the operation.

The old stump is then left to the mercy of the weather roughly hewn, inviting the inroads of fungal parasites and the depredations of white ants.

The utility of the type of grafting, apart from the decorative reasons, lies in the same direction as the bottle graft. Spurs situated on the main arms, near the trunk, can be worked over later to take the place of the main arms.

Grafting the Fig.

The fig has generally been regarded in the past as difficult to graft. This we found was not substantiated. The fig is easy to graft, but the stock must be vigorous: the callousing process takes a long time, and in weak stocks the scion dies before a union of the surfaces in contact can take place. The chief methods of grafting this tree are:

(1) *The Cleft Graft.*—Here the graft is overhead and care is necessary that the whole tree is not grafted in the one season, and that the grafts are carefully waxed. In the section on apple and pear grafting the system will be more fully described.

Cleft Grafting.—The Fig.—The success of the operation is obvious. The grafts were done in September, 1931, finalizing the top-working of the tree commenced in 1930.

(2) *Bark Grafting.*—The method involved in this system of grafting will be described in detail later. The same precautions as in the cleft grafting must also be observed.

We have obtained equally satisfactory results with both types of grafting. The scion growth has been vigorous, but care is necessary that the profusion of sucker growth does not smother or dwarf the grafts that are usually later in starting growth than other kinds of grafted trees.

Grafting the Apple and Pear.

These are two of the easiest kinds of trees to graft, and the usual method of changing the variety or "top-working" is by grafting. The stock of the apple is often propagated by root grafting, and is practically the only stock treated in this way.

When top-working an old tree to change the variety, it is usual to cut the top of the tree back to the secondary arms (using a sharp fine-toothed saw. If the tree is very large it may be advisable to spread the operation over two seasons, doing one-half of the tree one year, and the remainder the following year. Another method of dealing with large trees is to cut the limbs off at a considerable height and insert the grafts there. This usually means that many extra scions must be used, but it lessens the shock to the tree, and the resulting rapid growth of the scions makes the extra trouble well worth while.

After the tree has been cut back, one must decide which method, or type, of graft should be employed. This is governed largely by the size of the limb or stock to be grafted.

For limbs up to three inches in diameter the cleft-graft gives good results. The chief advantages of this method are that the scions are held firmly in position without the necessity of tying, and that, unlike the bark graft, this method can be done before the bark lifts easily. One disadvantage is that the cleft or crack may harbour disease, but if the work is carried out carefully this possibility is almost negligible.

Method of Cleft-Grafting.

After the stock has been sawn off, trim the rough edges of the bark with the knife, and then with a wide chisel or grafting tool split the limb across the diameter to the depth of 2 to 3 inches. Insert a hardwood wedge to hold the cleft slightly open while the rough edges of the cut are trimmed and smoothed to a narrow V-shape.

Next, select the scion (usually three buds are sufficient) and cut it wedge-shaped and slightly thinner on the inside. This will ensure a firm

pressure being kept where the cambium layers contact. When cutting the scion for this, and all other grafts, make the cut in such a manner that the top or terminal bud will be facing the direction that you wish the graft to grow. When the scion has been cut to fit snugly in the cleft of the stock, insert it in such a manner that the two cambium layers are in contact, then withdraw the hardwood wedge, thus allowing the two sides of the stock to hold the scion firmly in position. Unless the stock is very small it is usual to insert two scions, one on either side of the cleft. When the scions are firmly in place, wax over all cut surfaces and the job is complete.

Method of Strap Grafting.—Where the limb of the stock is over three inches in diameter, it is advisable to use the "strap" graft. This method is somewhat more involved than the cleft, but gives very good results, and the cut end of the stock is more quickly healed over. When using the strap-graft the stock is cut and smoothed off in the same manner as when using the cleft.

The scion needs to be a comparatively long one. In gauging the length of the scion, allowance must be made for the diameter of the stock. Allow the usual three buds, the diameter of the stock *plus* about two inches for the "turn down" on the opposite side. Thus, to graft a stock four inches in diameter one would need a scion about nine inches long. To shape the scion, make a long sloping cut, starting about three inches below the third bud and cutting one-third of the way through the scion, and to within half-an-inch of the bud. Then start from the bottom of the scion at the opposite side and cut a thin strip of bark and wood right up in level with the top of the previous cut. Then turn the knife at right angles and cut through to the first incision.

Now raise the bark on one side of the stock and insert the shorter side of the scion, turning the longer side, at right angles so that it lies across the diameter of the stock. Bend down the projecting end, and after opening or raising the bark, insert this bent-down portion.

If the edge of the stock is rounded off it will prevent the "strap" from breaking at that bend.

The stock is then bound round with twine to hold the scion in position, and then the whole of the cut surfaces are covered with wax or clay to exclude the air.

Method of Bark Graft.—Another type of graft often used in conjunction with the "strap" graft on a large limb is the bark graft. This is a very simple graft and consists of merely cutting the scion with a long sloping cut to form a "chisel point". This is then inserted under the bark in a similar way to the two separate points of the strap-graft. After

tying in place, wax or clay is used to exclude the air. One big drawback of this method is that until the growing scions have healed on strongly they are very apt to be blown out by the wind.

Method of Whip and Tongue Graft.—If one desires to graft very small limbs, say, upto three-quarters of an inch in diameter, the "whip and tongue" graft may be employed. This is the method generally used in root grafting apple stock. It gives best results when both stock and scion are nearly the same diameter.

The stock is prepared by making two sloping cuts. The first is the downward cut, which should be little over an inch long, turning slightly with the grain, and cutting about half-way through the stock. The second cut is made upwards, commencing from the opposite side level with the bottom of the first cut, and meeting the first cut, at a very acute angle, near the middle of the stock. These two separate cuts leave a long sloping surface with a wedge like a tongue.

The scion is prepared in a similar manner, but in this case the position is reversed and the upward cut is made first.

The stock and scion are then fitted together, and if they are of the same diameter will form a neat and firm joint with the cambium layers in contact all round. If the stock and scion are not of the same size, make sure that the cambium layers contact on at least one side. The graft is completed by binding with waxed cloth or by tying with raffia and waxing over.

There is another type of graft which is sometimes used—the side-graft.

Method of Side Graft.—Where a big tree has been worked high up, the side graft is used to form new laterals or fruiting wood on the old limbs. It is also used to form an extra "leader", where another variety is needed for cross-pollination. In using this method of grafting it is not necessary to cut the stock back as the graft is inserted in the side.

An oblique cut is made in the side of the stock with a thin chisel or a strong knife, and the scion, after being prepared in a similar way to that of the bark graft, is inserted and tied in position. As in all other grafts care must be taken to see that the cambium layers are in contact.

Where this method is used to form a new leader the top of the st ock can be cut off after the graft has taken.

When top-working any of the stone fruits—peaches, plums, apricots, etc., the general practice is to cut the tree back to the secon dary arms while the tree is dormant, and then bud the resulting fresh growth during the following summer. A quicker result may be obtained by cutting the tree back during the early spring and grafting in the same manner as when top-working apples and pears.

We have seen peach trees worked in this manner make over six feet of growth during the first season, and produce nearly a bushel of fruit the following year. The advantage of this method is that if the grafts should fail the trees always make sufficient new growth suitable for budding in the usual manner. Although stone fruit can be satisfactorily top-worked we do not recommend this operation on trees that are over twelve years old. The grafts will probably take all right, and may produce quite a good tree, but the cut stump is usually very slow in healing over. Dry rot and even white ants are very liable to gain access and so weaken the stump, that when the rejuvenated top is carrying a nice crop of fruit the main limbs will break down and the tree is ruined.

Most varieties of stone fruits may be worked one on to another, *i.e.*, plums on to peaches, and *vice versa*, but it is generally safest to keep the plum stocks only for plums. English plums top-worked on Japanese plums and the reverse operation are not always satisfactory. The peach stocks give good results all round, but especially as a stock for plums and apricots on light soils.

Care must be taken when working English plums on to peaches for some varieties do not make a good union. The "Grand Duke," for instance, seldom unites satisfactorily. It generally grows vigorously, but there is always an unsightly bump where the union has taken place.

Where it is desired to work the "Grand Duke" on to a peach stock it is necessary to double work the tree to get a neat union. The peach is first worked with a variety such as the "President," which will make a good union and then the "President" is later worked over to the "Grand Duke".

Peaches and plums generally take well on to almond trees, and we have had good results when top-working apricot trees with peaches and Japanese plums.

The same types of grafts as used for the apple and pear may be employed in grafting the stone fruits.

Grafting Citrus.

Citrus trees may be top-worked like any other kind of fruit tree. Although budding is generally employed for this operation we have had excellent results with grafting. As with top-working other varieties of trees, if the grafts happen to fail one can always resort to budding later on in the season.

In grafting citrus it is advisable to cut back only about half the number of limbs during the first year so that sufficient top is left to shade the main limbs which are very prone to sunscald. The remaining limbs may be cut back and grafted during the following year. This method always

allows one to harvest a portion of the usual crop for a season after the first grafts are inserted.

Best results are obtained by grafting citrus early in October, just before active growth commences, and before the weather becomes too hot.

The cleft-graft, as described for the apple and pear, is very successful for top-working the orange. The scion should be cut from good round wood of one to two years old and should be about the thickness of a lead pencil.

Another graft which may be used with good results is the " Crown " graft, as used when grafting the grape vine. In this case the main trunk is cut off at ground level and several scions are inserted, either the " cleft " or the " bark " graft may be used. The whole lot is then covered with soil leaving only the top buds protruding. After growth commences all but one—the most suitable scion—are removed. The selected one is then trained as a new tree. This method has a serious drawback in that the sawn-off stump left in the ground is liable to rot, and to harbour the *Armillaria* fungus, which is a serious trouble with citrus.

Bridge Grafting and Inarching are two special modifications of the practice of grafting.

Bridge grafting, as its name implies, is generally used for bridging over any extensive injury to the bark of the trunk or main limbs of a tree.

The operation is performed by taking a scion—usually the same variety as the tree being treated—several inches longer than the length of the injury to be bridged. The scion is shaped at both ends in the same manner as when doing the bark-graft. An opening is then made an inch or so below the injury by making a "T" cut through the bark and raising the two edges. A similar opening is made just above the injury by making an inverted " T " incision.

The scion is then bent bow fashion while the two ends are inserted in their respective openings. The scion is then allowed to straighten and the shaped ends are forced into position under the bark with their cambium layers in contact with the cambium of the stock. The graft is then tied in position and covered with wax or clay.

If the operation is being done before the sap is moving, *i.e.*, before the bark lifts readily, the scion may be inserted by making an oblique cut through the bark into the wood instead of the " T " incision. One must then use extra care to make sure that the cambium layers are in contact.

Bridge-grafting has its special value in saving trees that have been partly or wholly ringbarked by bark-eating animals, or by the attacks

of fungus diseases such as Collar Rot and Fire Blight. It is quite safe to bridge-graft any injured tree provided the bark is healthy immediately above and below the injury. In the case of a large injury, two or more scions may be inserted so that there will be less check to the normal flow of sap.

Where a tree has had a severe injury to the trunk and there is no healthy bark below the injury, the tree can often be saved by "inarching". This operation consists of planting a young tree, or cutting, close to the trunk of the injured tree and then grafting or inarching it into the healthy trunk above the injured portion. The method of operation is similar to that of inserting the top end of the scion when bridge-grafting.

The young tree or cutting must be planted during the dormant season. Although the inarching is best left till both trees are showing signs of growth, we have had good results with inarching apple-trees at various times between August and November. The scope of inarching is much wider than that of "bridge-grafting," for it may be used not only in case of injury to the trunk, but also, if necessary, to give a tree a complete new rooting system—perhaps of a different variety from its original system.

CONCLUSION.

Apart from the commercial systems of grafting, there are many types of fancy grafts that can afford much pleasure to those interested. The various forms of grafting by approach can increase the size of show fruit and can interlock trees and branches together into fantastic shapes. The procedure of grafting operations is similar to the method described previously under inlaying the grape vine or under inarching.

In conclusion, we would like to emphasize that for successful grafting one must carefully observe:

(*a*) The condition of the tree or vine—if too old, or diseased in any way, it is preferable to use fresh plantings. One sometimes sees instances of old trees grafted. For a time the scions make vigorous growth until the previous balance between the roots and the aerial portion is reached. The tree then relapses into its former condition of senility.

(*b*) *The Affinity between Stock and Scion.*—This must be ascertained from an authoritative source.

(*c*) *Method.*—Whatever method of grafting is used the work must be done carefully, and the cambial layers of stock and scion must be in close and intimate contact.

(*d*) *Season.*—The tree or vine must, together with the scions, be chosen at the right stage of development.

(*e*) That care of the growing scions is necessary for successful results.

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THE JOURNAL OF THE MYSORE AGRICULTURAL & EXPERIMENTAL UNION

Vol. XIII] 1932 [No. 1

PRINCIPAL CONTENTS.

The Irwin Canal Farm—By B. Narasimha Iyengar, B.A., Ph.D.

River-bed Cultivation in the Shimoga District—By A. K. Yegnanarayana Iyer, M.A., Dip. in Agri. (Cantab.), N.D.D.

CONTENTS.

	Pages
Mysore Coffee Experiment Station, Balehonnur ..	1— 3
The Irwin Canal Farm—By B. Narasimha Iyengar, B.A., Ph.D.	3— 7
River-bed Cultivation in the Shimoga District—By A. K. Yegnanarayana Iyer, M.A., Dip. in Agri. (Cantab.), N.D.D.	7—11
A New Contrivance for the control of the Early Stages of the Jola Grasshopper—By T. V. Subramanya Iyer	11—13
Anthrax—By K. Ranganatha Rao, G.B.V.C.	13—18
SELECTIONS—	
Honey as a Medicine—Agriculture and Economic Depression—Artificial Production of Rain—Toxicity of Root Excretions—Conservation of Grass in Transportable Form (Grass Cakes)—Management of Farmyard Manure—Vegetative Propagation—Indian Sugar Industry in 1930-31—By-Products of the Sugarcane Industry—The Rise of Bee-Keeping	19—55

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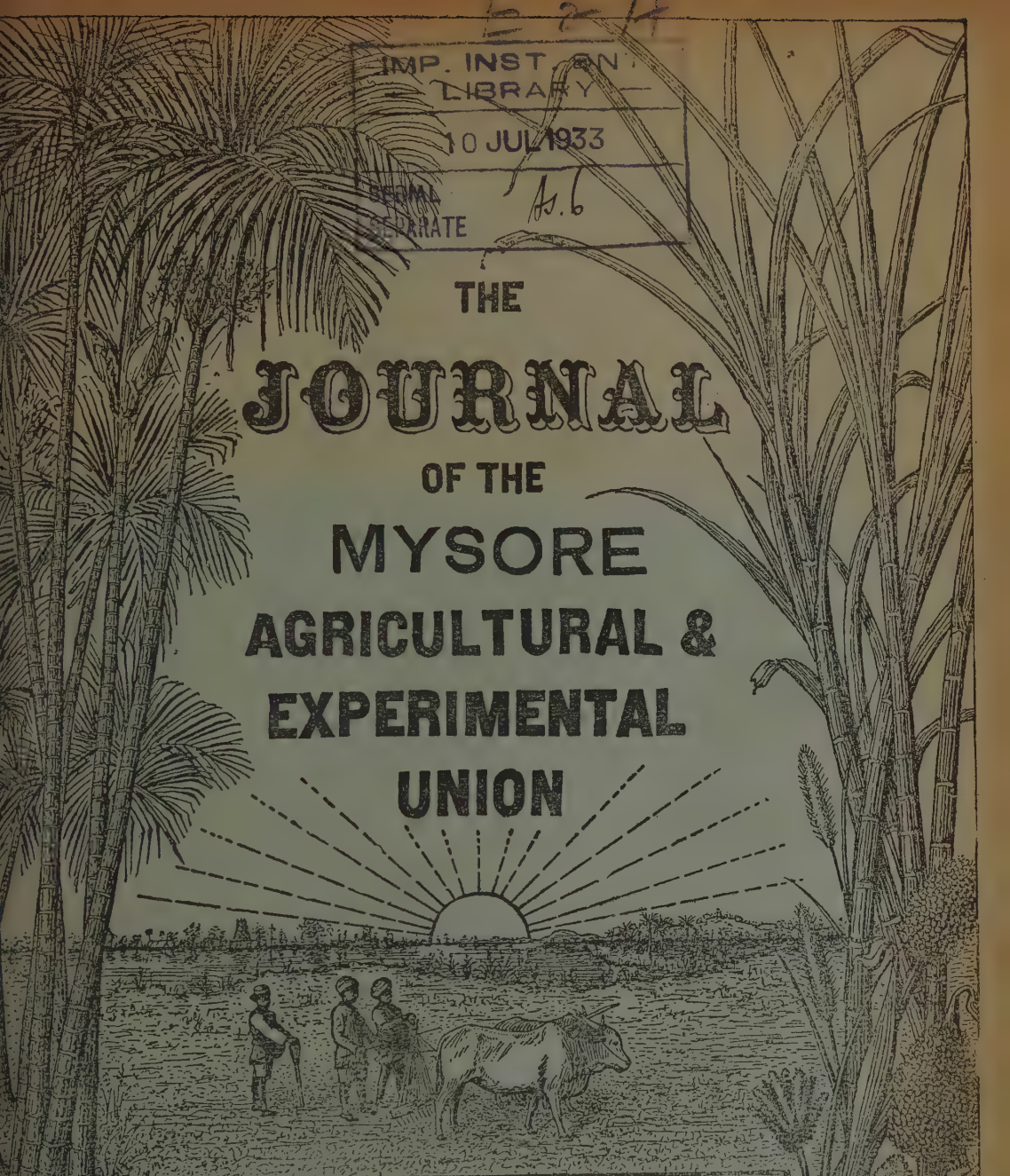

Vol. XIII] 1932 [No. 2

PRINCIPAL CONTENTS.

The Insecticidal Properties of Indigenous Vegetable Fish Poisons—T. V. Subramaniam.

Groundnut: Soil, Rainfall, Cultivation, Varieties under cultivation, Pests and Diseases—Venkata Rao K. Badami, L.Ag., Ph.D. (Cantab.).

CONTENTS.

	Pages
The Insecticidal Properties of Indigenous Vegetable Fish Poisons—By T. V. Subramaniam	57—60
Groundnut: Soil, Rainfall, Cultivation, Varieties under cultivation, Pests and Diseases—By Venkata Rao K. Badami, L.Ag., Ph.D. (Cantab.)	60—81
SELECTIONS—	
No Loss of Moisture by Capillarity in our Dry-Farming Areas—Grafting *versus* Seeds in Coffee—The A.I.V. Process of Conserving Green Fodder—Poultry Keeping—Practical Immunization of Plants by Genetic Methods—Green Manuring of Paddy—Science and Animal Production ; Breeding: The Application of Genetics	82–106

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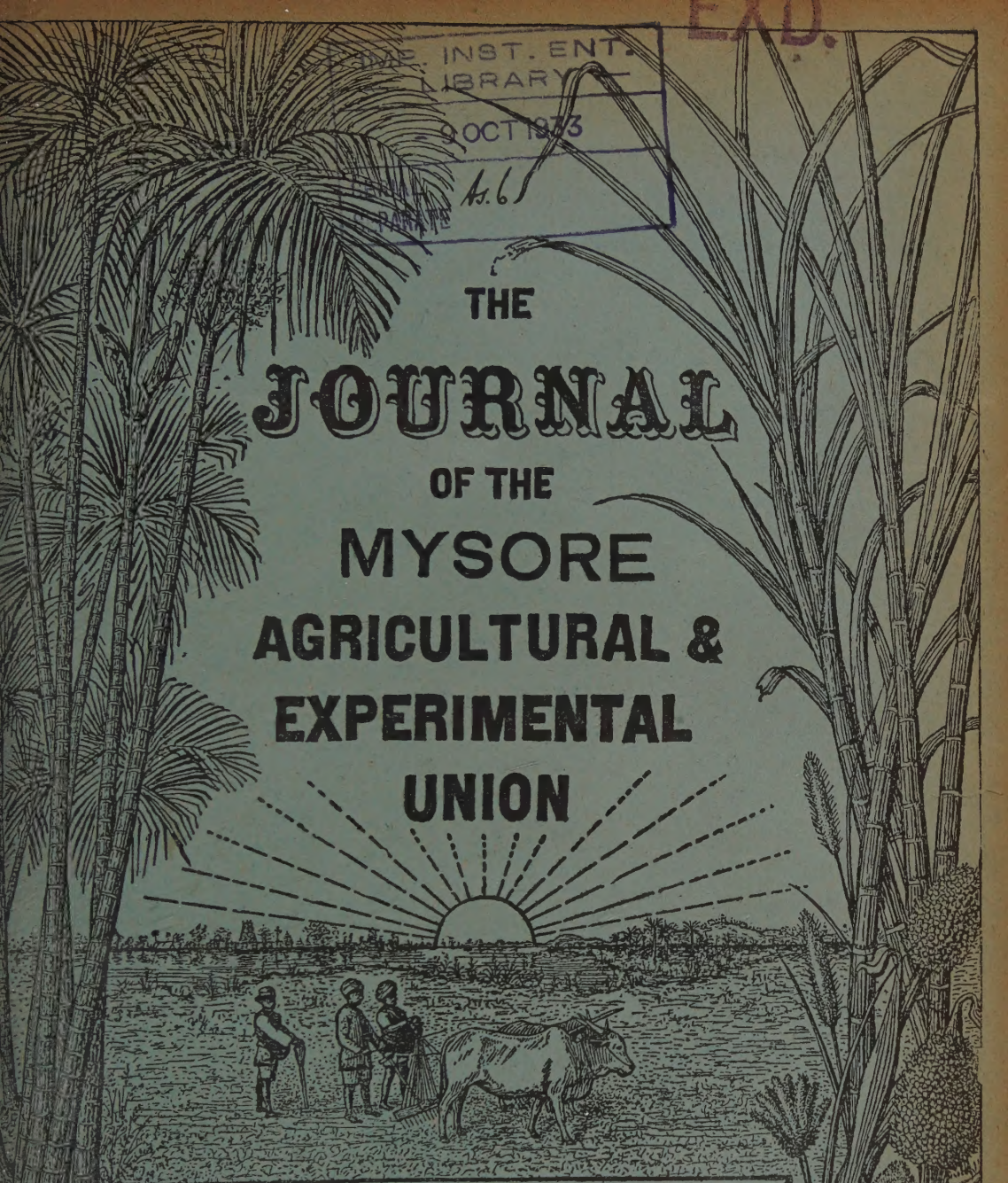

Vol. XIII] 1932 [No. 3

PRINCIPAL CONTENTS.

Groundnut : Its Products, Composition and Uses—By Venkata Rao K. Badami, L.Ag., Ph.D. (Cantab.).

Some Additional Money Crops for the Shimoga Malnad—By A. K. Yegnanarayana Iyer, M.A., Dip. in Agri. (Cantab.), N.D.D.

CONTENTS.

	Pages
Downy Mildew: A Serious Disease of Grape Vines in Mysore—By S. V. Venkatarayan	107—110
Cultivation of Virginia Tobacco in Whitefield—By T. S. Raghavachar, B.A.	110—115
Groundnut: Its Products, Composition and Uses—By Venkata Rao K. Badami, L.Ag., Ph.D. (Cantab.) ..	115—131
Johne's Disease—By K. Ranganatha Rao, G.B.V.C. ..	132—134
Some Additional Money Crops for the Shimoga Malnad—By A. K. Yegnanarayana Iyer, M.A., Dip. in Agri. (Cantab.), N.D.D.	135—137
SELECTIONS—	
On the Growth of Cocoanut Roots—Coffee Grafting—Potato Growing in Victoria—World Industry in Cocoanut Palm Products—Sesamum	138—162

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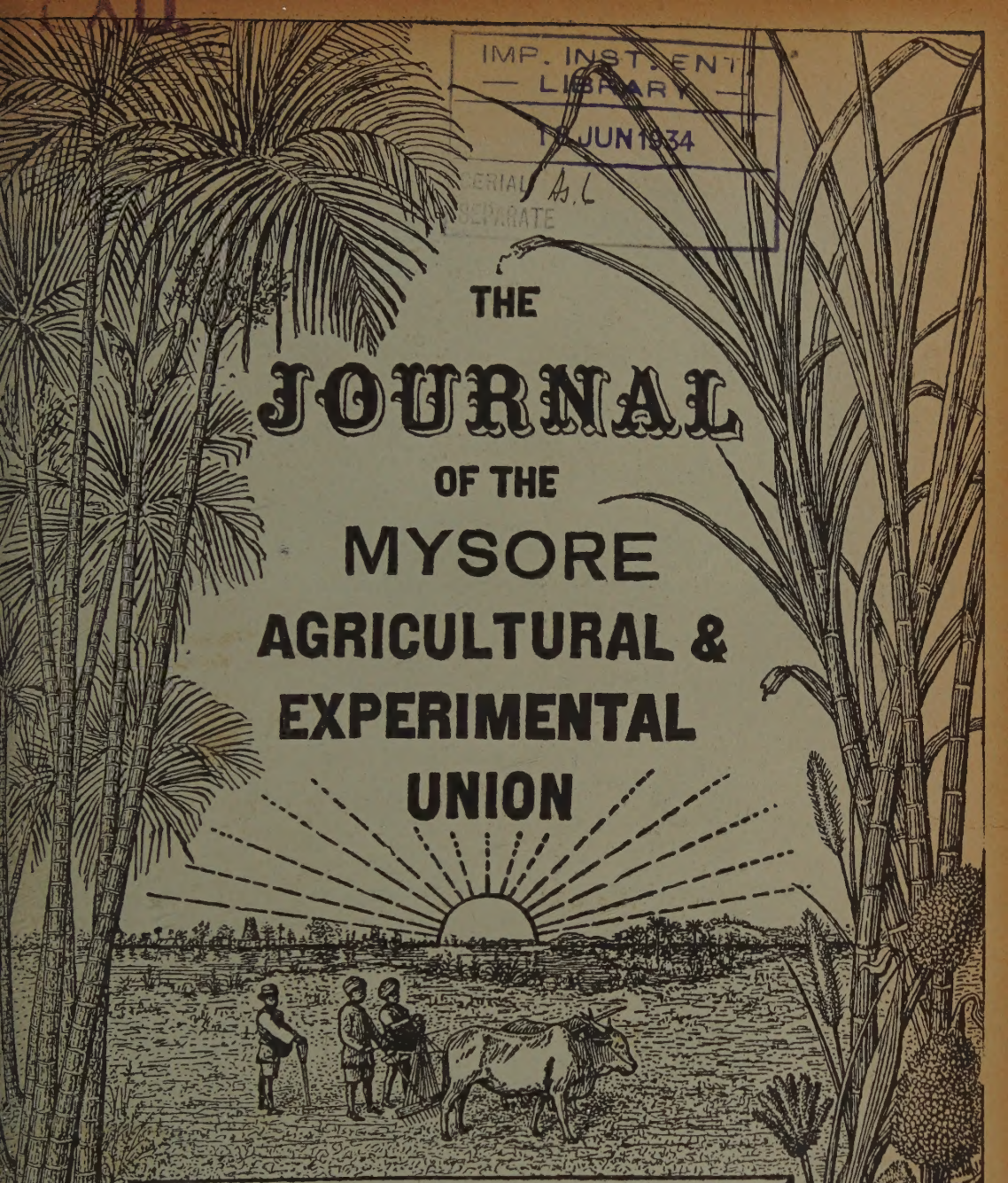

Vol. XIII] 1932 [No. 4

PRINCIPAL CONTENTS.

Proceedings of the Fourteenth Annual Session of the Agricultural and Experimental Union.

Groundnut : Commerce—By Venkata Rao K. Badami, L.Ag., Ph.D. (Cantab.).

CONTENTS.

	Pages
In Memoriam: Dr. M. K. Venkata Rao, M.A., M.SC., PH.D.—By M. J. Narasimhan	163—165
The Fourteenth Annual Session of the Agricultural and Experimental Union—	
Speech by Dr. Leslie C. Coleman, C.I.E., M.A., PH.D. (*President*)	166—171
Annual Report by the Secretary	171—177
Opening Speech by S. P. Rajagopalachari, Esq., B.A., B.L., *Member of Council*	178—181
Groundnut: Commerce—By Venkata Rao K. Badami, L.AG., PH.D. (Cantab.)	181—196
SELECTIONS—	
Field Propagation of Cotton by means of Grafts—A Note on Tung Oil—Notes on Tobacco Cultivation—Some Methods of Grafting	197—218